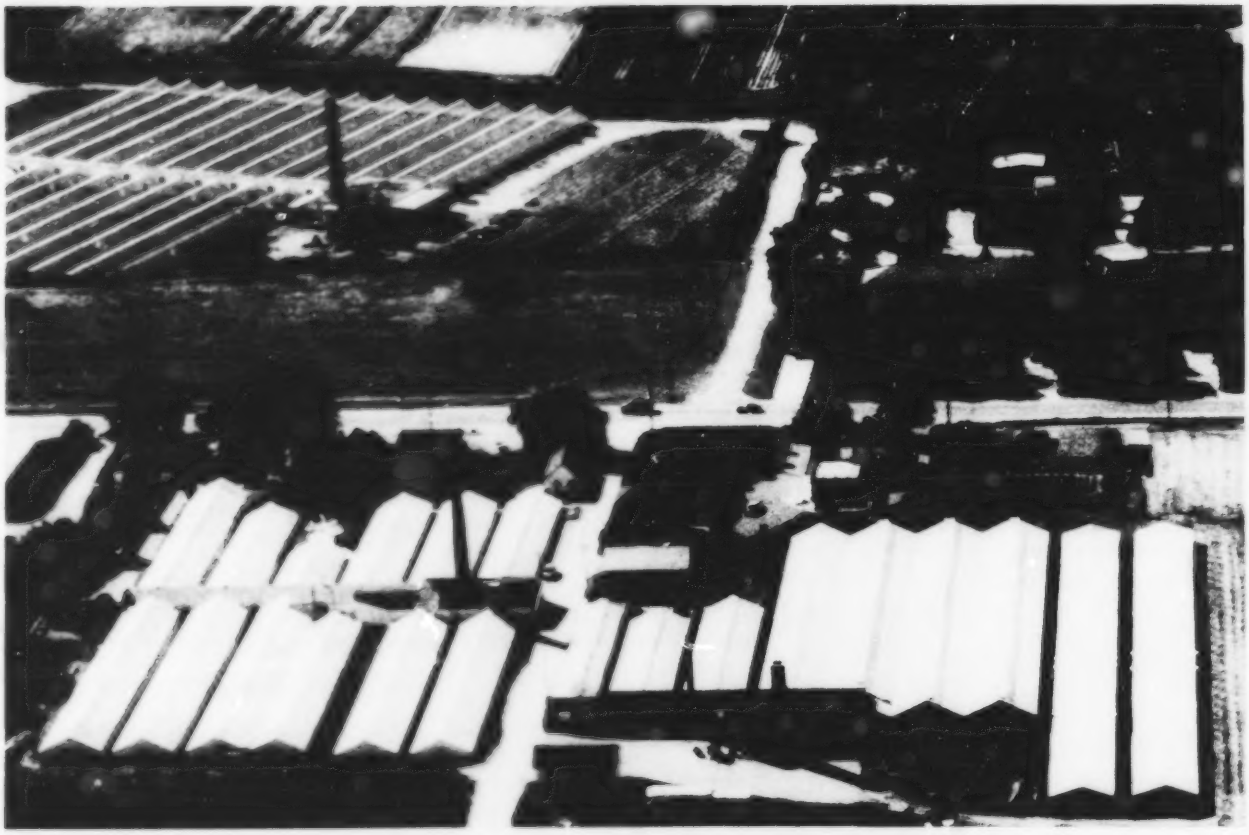
PUBLICATION 365
Revised Jan. 1990

PEST MANAGEMENT RECOMMENDATIONS for ONTARIO GREENHOUSE CROPS



Ontario
Ministry of Agriculture and Food
David Ramsay, Minister

To the best of the collective knowledge of the members of the Ontario Crop Protection Commitee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 13, 1989.

The information presented on the pesticide container label regarding application rates and methods of application is the final authority and where conflicts occur between this publication and the container label, the latter applies.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication do not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. **OLD EDITIONS SHOULD BE DISCARDED.** Health and Welfare Canada has established maximum residue limits (MRL's) for pesticides. However, growers should be aware that processors or retailers may demand different pesticide limits. Growers should seek advice of their intended market as to which restrictions or limitations are applicable.

For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel listed on page 2.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulation 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario Regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**

   Implies that all federal departments involved in the registration process agree that the data package was acceptable at the time of registration.

2. **Temporary Registration**

   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.

3. **Temporary Registration (Restricted Class)**

   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year. The pesticide product presently carrying a temporary registration (restricted class), classified for use in Ontario and included in this publication: Afugan (pyrazophos). This material may, or may not, be available for use in 1990.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

A procedure has recently been put in place to upgrade the classification process for pesticide products. This procedure provides for "interim status" products. These products are proposed by the Minister for inclusion in a schedule to Regulation 751, and the proposal is published in the *Ontario Gazette*. A person who sells or uses such a product as if it were in the specified schedule is exempt from the prohibition against sale or use of an unscheduled product.

For updated information on the regulatory status of these or other pesticides, contact the Agriculture & Industrial Chemicals Section, Hazardous Contaminants & Standards Coordination Branch, Ministry of the Environment, Toronto, Telephone (416) 965-2401.

CONTENTS

90-06118//

Policy Statement — Registration ..... Inside Front Cover
Horticultural Crop Advisors 2
Pesticide Management Advisors 2
Ministry of the Environment Field Offices 3
Precautions with all Pesticides 4
If Accidents Occur 4
Relative Toxicity to Applicator 4
Pesticide Regulations 5
Blood Tests for Those Applying Pesticides 5
Protective Clothing when Using Pesticides 5
Reentry to Treated Areas 6
Storage of Pesticides 6
Disposal of Pesticide Containers or Contaminated Material 7
Shelf Life of Pesticides 7
Types of Application Equipment 7
Wetting Agents 7
Water for Irrigation and Pesticide Application 8
Wood Preservatives 8
Acidity and Alkalinity 8
Pest Management Strategies for Greenhouse Flower Crops 9
Monitoring 9
Cultural Controls 9
Environmental Control 11
Biological Control 11
Chemical Control 12
Soil Drenches 12
Compatibility of Pesticides 12
Pesticide Toxicity Chart 13
Major Greenhouse Pests 15
Occasional Greenhouse Pests 19
Major Greenhouse Diseases 22
Fungicide Activity Chart 23
Growth Regulators 24
Growth Regulator Recommendations for Greenhouse Floriculture Crops 26
Pesticide Injury to Flower Crops 28
Pest and Disease Control for Flower Crops
—African Violet 29
—Azalea 30
—Bedding Plants 31
—Begonia (Rieger) 32
—Bulb Crops 33
—Calceolaria 34
—Carnation 35
—Chrysanthemum 36
—Cineraria 38
—Cyclamen 39
—Exacum 40
—Foliage Plants 40
—Geranium 41
—Gerbera 42
—Gloxinia 43
—Gypsophila 43
—Hydrangea 44
—Lily (Easter) 44
—Poinsettia 45
—Rose 47
—Snapdragon 48
Greenhouse Vegetables
—Crop Protection 50
—Integrated Pest Management 50
—Rockwool, Peat Bags, Nutrient Film Technique 51
—Tomato Seed Treatment 53
—Ornamental and Fruit Plants in Vegetable Greenhouses 53
—Cucumber Disease Control 53
—Cucumber Insect Control 54
—Tomato Disease Control 56
—Tomato Insect Control 57
—Pepper Disease Control 58
—Pepper Insect Control 58
—Lettuce Disease Control 58
—Lettuce Insect Control 58
—Summary of Registered Pesticides for Greenhouse Vegetables 59
Metric Information 62
Related Publications 64

HORTICULTURAL CROP ADVISORS
ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Counties Served/Specialty	Name	Address	Phone No.
Greenhouse Flowers	John Hughes	Horticultural Science Dept., University of Guelph Guelph N1G 2W1	519-824-4120 ext. 8910
Greenhouse Flowers	Wayne Brown	Vineland Station L0R 2E0	416-562-4141
Greenhouse Vegetables	Clem Fisher	Research Station, Harrow N0R 1G0	519-738-2251
PEST MANAGEMENT ADVISORS			
Greenhouse Flowers	Graeme Murphy	Vineland Station L0R 2E0	416-562-4147
Greenhouse Vegetables	Gillian Ferguson	Harrow N0R 1G0	519-738-2251
HORTICULTURAL CROP ADVISORS			
Marketing Eastern Ontario	Bob Cobbledick	Vineland Station L0R 2E0 College of Agricultural Technology Kemptville K0J 1G0	416-562-4147 613-258-8359
Prince Edward, Hastings	Allan Moynes	P.O. Box 470, Picton K0K 2T0	613-476-3224
Northumberland, Peterborough	Dave Ridgeway	P.O. Box 340, Trenton K8V 5R5	613-392-3527
Durham, Victoria	Tom Clarke	234 King St. East, Bowmanville L1C 1P5	416-623-3348
York, Peel	Chris Kessel	35 VanKirk Dr. Unit 9, Brampton L7A 1A5	416-451-5474
Simcoe, Dufferin, Grey	Ken Wilson	P.O. Box 69, Clarksburg N0H 1J0	519-599-2042
Halton, North Wentworth	Joe Uyenaka	R.R.#1, Ancaster L3Y 3K9	416-527-2995
Niagara Peninsula	Burke McNeil	Vineland Station L0R 2E0	416-562-4147
Norfolk, Brant, Haldimand	Steve Rowe	P.O. Box 246, Simcoe N3Y 4L1	519-426-7120
Oxford, Elgin, Perth, Waterloo	Keith Priest	P.O. Box 666, Woodstock N4S 7Z5	519-537-6623
Lambton, Middlesex, Huron	John Gardner	50 King St., London N6A 2P2	519-434-6811
Essex	Leslie Huffman	Research Station, Harrow N0R 1G0	519-738-2251
Kent	Ed Tomecek	College of Agricultural Technology, Ridgetown N0P 2C0	519-674-5456

In the event of a problem arising in connection with special pests, spray mixtures or spraying, telephone or write to the Horticultural Crop Advisor serving your area.

ONTARIO MINISTRY OF THE ENVIRONMENT
FIELD OFFICES

COUNTIES	FIELD OFFICES	TELEPHONE
Central Region		
Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	7 Overlea Blvd., 4th Floor Toronto, Ontario M4H 1A8	416-424-3000
Peterborough, Victoria, Haliburton Northumberland	139 George Street N., Peterborough K9J 3G6	705-743-2972
West Central Region		
Haldimand, Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ont. Gov't Bldg., 119 King St. W., Hamilton L8N 3Z9	416-521-7640
Southwestern Region		
Elgin, Middlesex, Oxford	985 Adelaide Street South, London N6E 1V3	519-661-2200
Essex, Kent, Lambton	P.O. Box 726, 435 Grand Ave. West, Chatham N7M 5L1	519-354-2150
Bruce, Grey, Huron, Perth	20 King Street, P.O. Box 688 Ont. Ministry of Agr. & Food Bldg., Clinton N0M 1L0	519-482-3428
Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	P.O. Box 820 133 Dalton St., Kingston K7L 4X6	613-549-4000
Prescott & Russell, Renfrew Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	2435 Holly Lane, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	199 Larch St., Sudbury P3E 5P9	705-675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	Ontario Government Building 435 James St. S., Thunder Bay P7C 5G6	807-475-1215
Head Office	Pesticides Section 135 St. Clair Avenue West, Toronto M4V 1P5	416-323-5095
Pesticide Licencing & Examination Section	Approvals Branch 250 Davisville Ave., 3rd Floor Toronto M4S 1H2	416-440-3713

PUBLICATIONS — The following publications are available from any of the field offices or from the Hazardous Contaminants Coordination Branch, Pesticides Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario M4V 1P5:

- Personal Protective Equipment for Pesticide Users
- Pesticides Safety Handbook
- Pesticides Act
- Index of Agent Codes
- Guidelines for Storage, Disposal and Transportation of Pesticides
- Fires and Stored Pesticides
- Pesticide Spills

READ THIS ENTIRE SECTION BEFORE USING ANY PESTICIDES

PRECAUTIONS WITH ALL PESTICIDES

General Precautions

1. Always read the label before opening pesticide containers, and follow all precautions and directions. Before starting, keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident.
2. Use an anti-backflow device, to prevent back siphoning, when drawing water from wells, ponds, streams and other sources. Mix the pesticide into the tank with sprayer at least 50 m from the water. Triple or pressure rinse the empty container and add rinse water to tank. Only mix enough solution to do the spray job. After loading and mixing, wash down gloves and boots with clean water before removing.
3. Never smoke, chew tobacco or eat while handling or applying pesticides. Do not carry tobacco or food items in clothing worn while spraying. Change clothing and wash before eating.
4. When handling and mixing concentrates, rinsing empty containers or repairing leaks, a full set of protective clothing should be worn including waterproof cap, coveralls, impervious gloves and boots, and eye protectors. If highly or extremely toxic pesticides are being used, a respirator should be worn. If very dusty formulations are being handled, a dust mask should be used. If volatiles or gases are being handled, a respirator must be worn. If these gases are highly dangerous or are used in an enclosed space, a self-contained breathing apparatus may be needed.
5. During application, a tractor cab with charcoal filter gives adequate protection against exposure. Impervious gloves, boots, coveralls and cap should be worn when tending to stoppages. When using airblast and mist blowers and tractors without cabs, a waterproof suit including a cap and impervious gloves and boots should be worn. When applying fumigants in the field, a respirator should be available in case of problems with equipment or if the fumigant is not adequately sealed in the soil and escapes.
6. When the spray operation is complete, bath or shower to remove pesticide deposits on the skin. Avoid handling anything in the home before bathing.
7. Well, pond and surface water may be contaminated by pesticides. Every effort should be made to keep this from happening. For more details, see the following OMAF Factsheets: *Management of Pesticides on the Farm*, Agdex 607, 88-083; *Pesticide Contamination of Farm Water Supplies*, Agdex 607, 88-077; and *Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure*, Agdex 607, 87-044.

   It is an offence to contaminate surface waters with pesticides. To prevent this from occurring:

   - keep pesticide concentrates above flood plain in a locked storage;
   - after emptying, triple or pressure rinse, crush and dispose of containers;
   - mix concentrate and water at least 50 m away from any water supply;
   - use appropriate buffer zones and berms to avoid surface water contamination of wells, ponds and streams;
   - if possible, do not use drinking water sources to fill spray equipment;
   - do not spray within 10 m of shallow wells or 5-10 m of other water supplies under ideal conditions and farther away if there is any air movement: stop spraying when wind velocity reaches 10 km/hr;
   - there are government programs to protect your water supply and assist in building pesticide storage facilities.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash gloves, boots, respirator before and after removal. Presoak clothes and double launder immediately. If the spill was serious, place the clothes in a plastic bag and dispose in a safe manner.
2. If clothing becomes wet with a pesticide during spraying, remove it immediately, wash and put on freshly laundered clothes.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common-name chemicals with you to the hospital (see Emergency Procedures for Pesticide Poisoning on the back cover).
4. Clean up any pesticide spills immediately. In the case of minor spills, use dry soil or other absorbent material to remove excess liquid and sweep up powders and granulars. Contaminated soil and sweepings should be spread over a larger area or bare soil to facilitate rapid degradation. Make sure you are adequately protected when cleaning up the spill.

   IN THE CASE OF A MAJOR PESTICIDE "SPILL", THE MINISTRY OF THE ENVIRONMENT, SPILLS ACTION CENTRE, 5TH FLOOR, 7 OVERLEA BLVD., TORONTO, ONTARIO M4H 1A8, TELEPHONE (416) 965-9619 OR 1-800-268-6060 MUST BE NOTIFIED.
5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

RELATIVE TOXICITY TO APPLICATOR

Definitions

Lethal Dose 50% (LD_{50}):

The dose which when administered will kill 50% of the test animals within a stated period of time (i.e. 1-6 days).

Acute Toxicity: Immediate adverse effects from a single or short-period exposure to a substance, either by the oral, dermal or inhalation routes.

Chronic Toxicity: Adverse effects resulting from repeated exposure to a substance over an extended period of time.

High Acute Toxicity
These pesticides are extremely dangerous if handled carelessly. The acute oral LD_{50} is less than 50 mg/kg of body weight and the acute dermal LD_{50} is less than 200 mg/kg body weight. These pesticides can be fatal by swallowing less than 0.1 to 3 mL (one drop to half a teaspoonful). These pesticides carry the skull and crossbones in a stop sign. In using these products a respirator and eye protection is required along with all other protective clothing:

aldicarb (Temik)
endosulfan (Thiodan)
methomyl (Lannate)
paraquat (Gramoxone)
parathion

Moderate Acute Toxicity
These pesticides are dangerous if handled carelessly. The acute oral LD_{50} is 50 to 500 mg/kg of body weight and the acute dermal LD_{50} is 200 to 2000 mg/kg body weight. These pesticides can be fatal by swallowing 3 to 30 mL (half a teaspoonful to 2 tablespoonsful). These pesticides carry the skull and crossbones on a stop sign. In using these products, a respirator and eye protection along with all other protective clothing, are recommended when handling the concentrate:

1,3-D (Telone II, Telone C-17, Vorlex plus, Vorlex plus CP)
daminozide (Alar)
diazinon (Basudin)
pirimicarb (Pirimor)

Low Acute Toxicity
These pesticides are not fatal unless deliberately ingested in amounts of over 30 mL (1 oz.). The acute oral LD_{50} is greater than 500 mg/kg body weight and the acute dermal LD_{50} greater than 2000 mg/kg body weight. Pesticides listed in this publication and not appearing in the lists in this section have low acute toxicities and should be handled with caution. Protective clothing is required. Respirators are advised when pesticides are used in confined spaces. Eye protection is advisable and other protective clothing should be worn.

Chronic Toxicity
It is not possible to assess chronic toxicity of a pesticide in the same way as an LD_{50} is used to determine acute toxicity. Instead, a number of tests are performed on animals which help predict whether a pesticide will cause a number of possible long-term effects. Animals are examined for a wide variety of toxic effects, such as the production of tumors or abnormalities. Protective clothing and equipment is advisable to reduce exposure and the risk of chronic effects:

1,3-D (Telone II, Telone C-17, Vorlex plus, Vorlex plus CP)

PESTICIDE REGULATIONS

An agriculturist may be briefly defined as a person who farms a minimum of 11 contiguous acres or has a minimum farm income of $12,000. At the present time, an agriculturist can buy and use pesticides in schedule 2, 3, 4, 5 and 6.

A licence to purchase and use methyl bromide can be obtained from your local Pesticides Control Officer or from:

Licensing Unit
Environmental Approvals and Land Use Planning Branch
9th Floor
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5

Telephone: (416) 963-3830

When using methyl bromide, or insecticide smoke generators, suitable protective clothing and breathing apparatus must be worn. After treatment, the greenhouse must be barricaded and warning signs posted. In general, smokes are especially useful for small greenhouses of 930 m^2 or less. Smoke applications are not satisfactory for spot treatment.

For methyl bromide, soil temperature should be above 15°C.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating the serum and the red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms.

For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should begin prior to using these pesticides and not after applications have commenced, since the normal level per individual can vary considerably, making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are:

carbaryl (Sevin)
demeton (Systox)
diazinon (Basudin)
methomyl (Lannate)
parathion
pirimicarb (Pirimor)

PROTECTIVE CLOTHING WHEN USING PESTICIDES

1. **Why Use Personal Protection?** Pesticide formulations vary in their toxicity from slightly to extremely poisonous. Once the pesticide is removed from the container, exposure occurs. The toxicity of the pesticide and the exposure to the user create a hazard which varies from spray operation to spray operation. Both can be reduced: toxicity by dilution, and exposure by protective clothing. The action taken by the applicator to reduce the hazard of a spray operation reduces the risk of poisoning. While the hazard of such a situation remains, the risk can be reduced by the care and protection followed by the applicator. Wearing the required protective clothing reduces the risk.

2. **Risk of each stage in pesticide operation.**
   (1) Handling and mixing concentrate – very high risk;
   (2) Rinsing empty containers – high risk;
   (3) Application outdoors – low to high risk;
   (4) Application indoors – medium to very high risk;
   (5) Clean-up, equipment rinsing – medium to high risk;
   (6) Reentry into treated area up to 48 hrs. – low to medium risk

3. **Exposure can be by way of skin, eyes, mouth, or nose.** Approximately 80-85% of the exposure in most spray operations occurs during mixing and loading of the concentrate. Field application usually accounts for 15-20% of the exposure. Skin exposure is usually 90 to 100% of the total exposure and around 70% of this is by way of the hands and forearms and 30% involves the rest of the body. Inhalation (nose and mouth) exposure is normally 0.1% but increases to 5-10% with mist blowers and air blast sprayers.

4. **To reduce skin (dermal) exposure** wear impervious gloves (neoprene, rubber, etc.) and waterproof boots, along with coveralls, apron or spray suits and waterproof cap. Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Polyester is more easily penetrated than cotton. Disposable coveralls are polyethylene and can be laundered several times. Spray suits should be used in highly hazardous conditions, such as with mist blowers and air blast machines. Eye protection should be practised with all pesticide concentrates.

5. **Respirators are recommended** when handling pesticides with labels carrying the warning stop sign with skull and crossbones that call for respiratory protection. Respirators should be used when spraying all pesticides rated as having a high toxicity or when applying any liquified gas. Respirators are available as air purifiers or self-contained units. Respirators come in a wide range of shapes and sizes; consult the label and your nearest safety supply company for advice.

6. **Washing and Laundering Protective Clothing.** To keep your protective clothing and equipment functional, clean it thoroughly. Never allow children or pets to come into contact with contaminated clothing or equipment. Launder clothing promptly, and wash and store other items used for personal protection. Rinse down spray equipment and store to prevent children playing on it. Here are some general guidelines for cleaning items used for personal protection.

   (1) Fabric Clothing. If fabric clothing is saturated with the concentrate of a highly toxic pesticide, then discard the clothing. Remove the clothing carefully and immediately place in a plastic trash bag and dispose in a safe manner. Wear rubber, vinyl, or plastic gloves when handling severely contaminated clothing. Presoak and double launder clothes that may have been contaminated by a normal spray operation, preferably twice a day but at least at the end of the work day, following these guidelines:

   - prerinse clothing outdoors;
   - presoak in a suitable container, such as a large bucket or tub; or use the prewash cycle of an automatic washer with detergent;
   - wash contaminated clothing separately from all other clothing;
   - prewash, solvent-based products have been found to be effective on EC formulations;
   - wash clothes using hot water, the highest water level, and a regular hot super wash cycle;
   - use heavy-duty liquid detergents for all pesticides and use adequate amounts (see laundry detergent box);
   - wash only a few contaminated garments at a time;
   - use two complete wash cycles, each with a double rinse;
   - after washing, run another wash cycle with only detergent and water to decontaminate the washing machine;
   - line dry to avoid a potential build-up of pesticide residues in the dryer.

   (2) Rubber, Vinyl, or Plastic Boots and Gloves. To avoid getting pesticide on your hands, wash the outside of boots and gloves with detergent and water before removing. After removing boots and gloves, wash them inside and out with detergent and water, rinse thoroughly and dry in a well-ventilated area.

   (3) Chemical-Resistant Clothing, Goggles and Face Mask. Wash plastic or rubber clothing and equipment with detergent and water, rinse thoroughly and dry in a well-ventilated area.

   (4) Respirators. Discard cartridges, canisters and filter pads: (1) when breathing becomes difficult; (2) when a pesticide odor is notice; or (3) at the time interval specified by the manufacturer. Write the date on the cartridge when it is first used. Wash the face piece in detergent and water, rinse it thoroughly, and dry it in a well-ventilated area. Never use alcohol or other solvents for cleaning, as they will damage rubber and plastic.

7. **Consult the safety supply house** of your choice for appropriate guidance and selection of your protective clothing.

REENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter greenhouses too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors. Examine the pesticide label for precautionary statements on working in treated areas.

For all materials in the form of smokes, aerosols or vapors, lock and post the greenhouse and ventilate to ensure safety before working in the greenhouse. The minimum interval between application and reentry for these products is 12 hours.

The pesticides listed below are those for which a specified minimum interval must be observed from the time of application to the time of working in the crop. The specified reentry period refers to the treated bed, ground bed, or bench specifically treated with these materials and not to the greenhouse range as a whole.

Minimum reentry time of **48 hours**:

Temik (Aldicarb)

Minimum reentry time of **72 hours**:

Telone
Telone II
Vorlex

Use a respirator approved for 1,3-dichloropropene if reentry is necessary to the greenhouse range prior to the specified 72 hour minimum.

STORAGE OF PESTICIDES

1. **General Storage:**

   The Ontario Pesticides Act and Regulation 751 require that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

Special Storage:

Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words **"CHEMICAL STORAGE WARNING — AUTHORIZED PERSONNEL ONLY"** in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide, or with his permission.

2. **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** Also see OMAF Factsheet, *Farm Storage of Pesticides*, Agdex 607.

3. Post pesticide storage areas with proper notices.

4. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems affecting humans, domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS OR CONTAMINATED MATERIAL

1. All cardboard pesticide containers or paper packaging materials, or other paper materials used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or outdoor public areas. Plastic material must not be burned.

2. Unrinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the container, it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful — why not use that 3% for the purpose for which it was purchased, to control the pest!

3. Rinse all empty metal, plastic or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic container, and rinse the residue left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table, or disposed of at a landfill site.

4. Unwanted or contaminated pesticide products should be disposed of through TRICIL Environmental Management (1-800-263-2432), or by contacting the appropriate registrant to develop an alternative method acceptable to the Director under the Pesticides Act (1-416-323-5095).

SHELF LIFE OF PESTICIDES

Most pesticides, if stored in a cool (not freezing), dry place, will remain effective for 2 years or more.

It is a good idea to mark the date of purchase on the package.

The following is only a guide to check the effectiveness of pesticides that have been stored.

Formulation	Do not use if:
Dust	excessive lumping is evident;
Emulsifiable and Spray Concentrate	the solution does not turn milky when mixed with water or if the mixture separates or if a sludge forms;
Granular	excessive lumping or caking is evident and it does not run freely;
Oil Spray	a milky solution does not form when mixed with water;
Wettable Powder	material is lumpy and powder will not mix with water.

TYPES OF APPLICATION EQUIPMENT

1. **Spraying** is one of the most widely used and effective methods of applying pesticides. The nozzles should be clean and pressure maintained to achieve a fine spray which will result in uniform coverage when the mixture is applied up to the point of runoff. Complete coverage is the objective; be sure to spray both the lower and the upper leaf surfaces thoroughly.

2. **Fogs** are produced by several kinds of machines. These machines all use heat from different sources to vaporize the pesticide. Fogging can be a very efficient method of pesticide application provided the operator follows basic instructions.

3. **Granular Application.** Several types of applicators are available for applying granular pesticides. Be sure the applicator does not grind or fracture the granules.

4. **Smokes** are a very simple but effective means of pesticide application. There is no equipment involved; containers are simply placed on the path and lighted. Growers should be cautioned against using smokes in very old, loose greenhouses, or during high winds.

5. **U.L.V.** There are several types of ultra-low volume applicators available that atomize the pesticide solution into an extremely small particle size (7-20 microns). Distribution through the greenhouse is by a forced air fan system.

WETTING AGENTS

In the following discussion, the term "wetting agent" will be used to include spreaders, stickers and surfactants, although these terms do have slightly different meanings.

Water will not always spread evenly over any surface. Its hydrophilic nature creates a high surface tension and when placed on a leaf (hydrophobic) surface will lead to large droplets forming which easily roll (with the pesticides) off the leaf and onto the ground. Reducing the surface tension of the water by adding a wetting agent allows the water to make better contact with the leaves. Consequently, this allows pesticides to spread more evenly on the leaf surface.

Most pesticides are formulated with a wetting agent in them, but in some cases, due to the temperature of the water or air, hardness of the water, type of leaf surface, stage of plant growth and/or the type of formulation, the amount may not be adequate. Consult the label for specific recommendations.

A simple method of determining if the amount of wetting agent present is sufficient is to spray about 3 metres of bed area. Examine both the upper and lower surfaces of leaves of different stages of growth to see if they are uniformly wetted.

If not, add 125 mL of spreader per 1000 L of spray. Spray another 3 metres of the bed and re-examine. Continue until wetting is satisfactory.

Wetting agents help the spray solution to "wet" powdery mildew mycelium and improve control. The use of an excessive amount of wetting agent can result in plant damage, excessive foaming, which will cause pumping problems, or runoff, resulting in poor control.

WATER FOR IRRIGATION AND PESTICIDE APPLICATION

It is very important to neutralize alkaline water when using the water for irrigation and pesticide spray-tank mixtures.

1. **For Irrigation.** For crop irrigation, water should have a pH in the 6.0 range (acidic) in order to improve nutrient uptake. Many water sources in Ontario have a high pH (alkaline) and need to be lowered.

   By testing the water, it can be determined both the quantity and type of acid that needs to be added in order to achieve the desired pH level. Consult your Greenhouse Crop Advisor and see OMAF Factsheet, *Water Quality for Greenhouse Crops*, Agdex 290/15.

2. **For Pesticide Spray-Tank Mixtures.** Because many pesticides decompose in alkaline water, it is recommended that pesticides diluted with alkaline water be used immediately.

   However, owing to many reasons, "spraying immediately" is not always possible. Any delay in applying spray mixtures will result in pesticide loss due to decomposition[1] and possibly a corresponding decrease in control.

   To avoid this possibility, it is recommended that alkaline water be neutralized before adding any pesticides. Dissolve ammonium dihydrogen phosphate at the rate of 50 g/100 L water first, and then add pesticides.

   The phosphate is not always necessary, but this practice provides a sort of insurance against pesticide loss. The cost of the phosphate is substantially less than that of the pesticides. Also, the added phosphate will be available as a foliar nutrient.

   Occasionally water-soluble fertilizers are used with pesticides as a tank mixture. In this case, it is important to choose acidic fertilizers; this makes the addition of ammonium dihydrogen phosphate unnecessary. Don't use alkaline fertilizers for this purpose. If alkaline fertilizers are used, the amount of phosphate recommended above will not be sufficient to neutralize the water, and the decomposition of pesticides may be enhanced.

   [1] *The rate of decomposition is dependent on the pesticide, the concentration of pesticide in the tank (dilution factor), and temperature.*

WOOD PRESERVATIVES

Wolmanized lumber is safe for greenhouse use, but copper napthanate has caused some crop injury to poinsettia. Other wood preservatives should not be used. Check with your Greenhouse Crop Advisor.

ACIDITY AND ALKALINITY

Soil pH The term pH represents the degree of acidity or alkalinity of a solution (or soil). It is measured on a scale of 0-14. A pH of 7 is neutral; values below 7 are called acid (sour), and those above are alkaline.

The pH is a very important characteristic of soil, as it influences the solubility and, thus, the availability of nutrients. Moreover, it indirectly influences the colonization of certain pathogens in the soil which may be harmful to plants.

Generally, a pH between 5.8 and 6.5 is an acceptable range for soil mixes or soil-grown crops. Azaleas and gardenias are exceptions to this rule, while it is optional for hydrangeas and hyacinths. The pH of a soil can change due to many different reasons (e.g., continuous use of certain fertilizers, pH of irrigation water, type of soil amendments, etc.). A regular check of soil pH, therefore, can be very helpful.

For soilless mixes with more than 50% organic material, the pH for optimal nutrient availability is between 5.0 and 6.0.

Any correction of the soil pH can be best done at the time of soil preparation prior to planting. Limestone (dolomitic or calcitic) is usually used to increase the pH to the desired level. For a bench crop (loamy soil), the following rule of thumb may be used: to increase the pH with 0.1 unit, use 4.8 kg of limestone per 100 m^2. For a soil with a higher clay content or a higher organic matter content, the recommended amount can be increased by about 25%. Two to 3 weeks after application, the soil pH should be checked to see whether the desired pH level has been attained. It may be noted that the finer the limestone, the quicker its reaction with the soil will be.

The rate of change is also affected by temperature, moisture and aeration conditions of the soil. Changes will occur most rapidly when soils or soilless media are warm, moist and well aerated.

The use of hydrated lime in greenhouses has some severe drawbacks, as it reacts very quickly and actively. Proper distribution of the material throughout the soil mixture is difficult and, consequently, the use of this material is very limited.

For potting mixtures, the amount of limestone to be added depends on the type and ratio of the ingredients. Sphagnum peat moss (pH 3.5 to 4.5) and bark (pH = 4.0) are acidic, while alkaline materials are often the baked clay types such as Turface, Haydite and Crackpot or Sand. The amount of limestone needed to neutralize sphagnum peat moss from a pH of 3.5 to 5.5 is about 6-7 kg/m^3 of loose peat moss. The addition of clay additives with a high pH should reduce the rate of limestone needed. A check of the pH of the mix should be made after preparation, but before planting.

There are different methods of lowering the pH in the growing mixture. Acidic peat moss, ground sulfur, iron sulfate and/or aluminum sulfate can be used as an amendment to a bench crop. Rates of application according to Cornell recommendations are listed in the table below.

Materials	kg/100 m^2 To Lower pH 1/2-1 Unit[1]	Rate of pH Change
Finely Ground Sulfur	2.5 kg	slow
Aluminum Sulfate	15 kg	rapid
Iron Sulfate	15 kg	moderate

[1] *Rates are for light to medium soils. For heavier soils with more organic matter, increase rate by one-third. The rates per m^2 of potting soils are one-half the above recommended rates.*

Low calcium and magnesium levels are becoming apparent in many greenhouse soils that have been in production for many years. The reason is that water-soluble fertilizers now in use lack calcium and magnesium because of the high phosphorus content. If the pH has dropped, the use of dolomitic limestone is recommended as a source of calcium and magnesium. However, if the pH has remained within the desired range, the use of gypsum (calcium sulfate) at rates of 10-50 kg/100 m^2 will supply calcium and Epsom salts (magnesium sulfate) at rates of 5-15 kg/100 m^2 will supply magnesium. Magnesium nitrate can also be used at a similar rate.

PEST MANAGEMENT STRATEGIES FOR GREENHOUSE FLOWER CROPS

Integrated pest management is a philosphy of pest control which utilizes all available control strategies to maintain pest populations of insects, mites or disease organisms below an **economic** injury level. It does not advocate a continuous pesticide spray program to "eradicate" pests, but promotes the integration of cultural, biological and chemical control strategies. The routine spraying of pesticides for "insurance" purposes is no longer likely to achieve effective control and in recent years this practice has led to a number of problems which include:

1. **Resistance.** With fewer pesticides being developed and registered, and more pesticides becoming ineffective because of the development of resistance, it is imperative that we learn to use the pesticides we still have more efficiently.
2. **Environmental.** Concerns over environmental pollution and groundwater contamination make it important that we examine ways to reduce our use of pesticides or their misapplication.
3. **Personal Health and Safety.** The problems involved in applying pesticides in the greenhouse or working in areas where pesticides have been applied also stress the need to look at our pesticide use.

The tools of pest management include:

MONITORING

We need to view monitoring as a means of providing us with information which guides the whole pest management program. For monitoring to be successful it must be done on a regular basis (e.g., once a week) and the information **must** be recorded so that growers can make use of the information in the future. The type of information which should be recorded includes:

- Date
- Pest identification
- Location in the greenhouse
- Numbers of insects trapped
- Stage (e.g., adults, pupae, etc.)
- Crop species and cultivar
- Control action (pesticide used, rate, area treated, time taken, etc.)

The most common monitoring technique employed in greenhouses is the use of yellow sticky traps (cards or tape) for monitoring many flying insects. They are especially good for whitefly, thrips, leafminer, fungus gnats and winged aphids. It is also worth noting that blue sticky traps have proven especially attractive to western flower thrips; however, if a wider pest complex is present, then yellow traps would be a better choice. It is important when using sticky cards to provide adequate coverage (one card every 100-200 m^2) and to change the traps before there are too many insects on it to maintain a weekly record (in some cases this may mean changing cards every week).

The other excellent monitoring technique which is often overlooked is that of crop inspection. It is essential for monitoring plant diseases, or the presence of mites, wingless aphids, or the immature stages of whitefly and leafminer. A regular sample pattern should be adopted which provides good coverage of the whole greenhouse, including entry points and known hot-spots. Again, records must be kept!

CULTURAL CONTROLS

1. Sanitation

Sanitation is the first step in any pest control program. If a source of infection is constantly present because of inadequate hygiene, then pest control programs will be expensive and frustrating. It is important to:

(a) Remove dead and dying leaves and flowers.

(b) Keep walks and the surfaces of beds clean.

(c) Remove crop residues well away and downwind from the greenhouse. Preferably burn residues or alternatively bag them and dispose of them.

(d) When bringing new stock into the greenhouse, check carefully for pest infestations.

(e) Avoid overwintering garden or house plants in the greenhouse. Pests will be maintained for an early invasion of the next crop.

In vegetable greenhouses there are usually a few weeks or months when the houses are empty between crops. To prevent disease organisms or some insect stages from carrying over on the empty structures, heating pipes, walks, benches or equipment, spray with:

(a) 10% sodium hypochlorite solution (commercial chloride bleaches). Add 1 part hypochlorite to 9 parts water; or

(b) 37% formalin solution – 30 L to 1000 L water.

Note both of the above solutions are toxic to plants

Immediately after spraying close the greenhouse for 3-4 days, then ventilate. CAUTION: Wear a respirator when spraying with formaldehyde or sodium hypochlorite.

Cleanliness in itself will not control pest problems but it is a basic component of any control program.

2. Soil Pasteurization

Greenhouse and field soils contain weed seeds, insects, bacteria and fungi which may be harmful to the plants to be grown. This includes potting mixes and their components, unless guaranteed to be sterilized or pasteurized by the manufacturer. Soil and potting mixes can be pasteurized to eliminate these harmful organisms. Ideally, this is accomplished without injuring beneficial soil organisms.

Soil should be in fine tilth to allow rapid, uniform penetration of the steam fumigant. Soil should be free from clods, large lumps and undecomposed crop remains.

The following chart gives an idea of the time-temperature relationships necessary to destroy undesirable organisms.

Weeds (most)	70°-80° C for 15 min
Insects and Mites	60°-71° C for 20 min
Bacteria (most)	60° C for 10 min
Fusarium	57° C for 30 min
Botrytis	55° C for 15 min
Nematodes	55° C for 15 min
Rhizoctonia	52° C for 30 min
Sclerotinia	50° C for 5 min
Pythium	46° C for 40 min

As can be seen from the chart, most organisms of concern to growers can be eliminated under ideal conditions of 60° C for 30 minutes. Above 82°C beneficial soil organisms start to be destroyed. If the soil is heated at too high a temperature for too long a time, it becomes sterile and subject to a greater degree of infection than previously, simply because all organisms have been destroyed. There are many other undesirable effects of oversteaming including:

(a) excessive ammonia release;

(b) manganese toxicity;

(c) higher total salts levels;

(d) destruction of organic matter.

Methods

1. Steam is the most common source of heat for pasteurization. There are different ways of handling steam, depending upon the type of crop being grown. When pasteurizing soil for vegetable seedlings or potted plants, growers find it is most efficient to inject steam into the bottom of a wagon or old truck body. After cooling, the pasteurized soil can be moved in mass to the area in which it will be used. Growers of cut flower or vegetable crops follow two main techniques. If their ground beds are drained with agricultural tile (top of tile 40 cm below the surface and rows on 60 cm centers) it becomes a very simple matter to inject steam into these tiles and very effectively pasteurize the soil to the sides and above them. If tiles are not installed, then the steam is injected directly under a tarp covering the bed through either a canvas hose or a perforated, flexible plastic field tile for even distribution.
2. Aerated steam is being used more widely today. In this system, live steam is mixed with air in a chamber and the mixture (at 70° C) is used to pasteurize soil. The lower steam temperatures allow the soil to be pasteurized and avoid any of the hazards of oversteaming. Unless there are specific problems, a soil temperature of 70° C is adequate for most insect and disease problems.
3. Electric soil pasteurizers are useful where small volumes of soil are used and no other method is available. Overcooking of the soil can occur very easily, because in order for the temperature between the finned heat source to reach 82° C, the fins themselves must be at a higher temperature.
4. Chemical fumigants such as Basamid, Methyl Bromide, Telone, Vapam and Vorlex can be used for pasteurizing soil for potting or in greenhouse beds or benches. Each of the fumigants mentioned has a specific rate and activity against soil-borne insects, diseases, nematodes, and weeds. Some formulations may be less effective against certain types of pests; see manufacturer's label. Crops in adjoining beds or benches may have to be guarded against accidental exposure to escaped fumes. Fumigants listed below are effective as preplanting treatments for **GREENHOUSE SOIL BEDS. AMOUNTS SHOWN ARE FOR 100 m^2.**

   (1) Control of nematodes only:

Telone IIB	– 2.0 L
Telone C-17	– 2.0 L
Vorlex Plus	– 2.5 L

   (2) Control nematodes, fungi, insects and some bacteria:

Basamid (granular)	– 3.25-5 kg worked in to a depth of 15-23 cm
Vapam (liquid)	– 10 L
Vorlex Plus (liquid)	– 6 L
Methyl Bromide/Chloropicrin:	
(a) pressurized cans 98%/2%	– 7.5-10 kg
(b) injectable 68%/31.8%	– 2.5-3.65 kg

For fumigation of soil in bulk piles or stacked flats with pressurized cans of Methyl Bromide-Chloropicrin (MB-C2, Bromogas), cover the pile or stacked flats with an airtight plastic cover and inject the Methyl Bromide-Chloropicrin mixture from pressurized can at 0.3 kg/m^3.

NOTES ON METHYL BROMIDE (1) The bromide residue that lingers in the soil after using Methyl Bromide may reduce the germination of and/or growth of salvia, dianthus, ageratum, alyssum, antirrhinum, aster, calendula, celosia, chrysanthemum, cleome, coleus, coreopsis, dahlia, digitalis, godetia, helichrysum, iberis, lobelia, matricaria, myosotis, nemesia, nierembergia, portulaca, salpiglossis, verbena, viola and vinca.

(2) Do NOT use Methyl Bromide prior to planting a lettuce crop or other leafy vegetables.

3. Weed Control

Control of weeds inside and outside the greenhouse is an important part of any pest management program. Weeds can provide a refuge for insect pests and act as a reservoir for diseases. A 5 m strip of carefully maintained lawn around and between greenhouses will also decrease the danger of invasion by insects and diseases from outside.

Cultivation and hand weeding are still the most practical methods of controlling weeds in greenhouses. However, other methods may also be useful in reducing the amount of labor required to keep weeds under control.

(a) **Steam.** As mentioned above, the use of steam to pasteurize soil will kill weeds and most weed seeds if the soil temperature can be held at 70-80° C for 15 minutes. Weed seeds in the outer layer of soil which has been at a lower temperature and weed seeds with hard seed coats may not be killed.

(b) **Soil Fumigation.** Metam sodium (VAPAM), dazomet (BASAMID), and VORLEX breakdown in the soil and produce a gas which kills many weed seeds, as well as nematodes, fungi, which cause "damping-off" and other plant diseases. They are, therefore, useful in treating seedbeds and potting soil. Methyl bromide is also effective for weed control and general soil sterilizing. It is a liquid which forms a poisonous gas when released from the container, and must be used under a gasproof cover, usually plastic.

(c) **Herbicides.** OMAF Publication 75, *Guide To Chemical Weed Control,* contains information on herbicides which are registered for use in Ontario. The treatments listed in the publication are based on extensive field trials and observations on farms. Herbicides may be particularly useful for weed control **outside** the greenhouse. There are **no herbicides registered for use inside greenhouses** and there is the potential for crop damage if they are used incorrectly. For example, turn fans off so as not to draw herbicide inside. A copy of Publication 75 is available at any OMAF office or from your Extension Horticulturalist. The information on chemicals, safety precautions and calibrations, care and use of sprayers should be read carefully.

Where unwanted pesticide residues remain in soil, an application of **activated charcoal** can reduce the problem. The rate will vary depending on the type of chemical contaminant and its concentration. A usual range is 0.5 to 1.5 kg/100 m^2.

4. Screening/Physical Control

In many instances, the use of screens over vents can greatly reduce the influx of insect pests from outside. For smaller insects such as thrips, screens need to be of a very fine mesh, which can be expensive and will require increased surface area to compensate for decreased air flow.

Another method of physically controlling insects is by the use of large quantities of yellow sticky tape (which works on the same principle as the sticky cards used for monitoring). When tape is strung along beds or benches, it can provide significant supplementary control when used in conjunction with other control methods.

5. Resistant Cultivars

Many species of plants display varietal differences in their susceptibility to insect and disease attack. Genetic manipulation of field crops has provided growers with many choices of cultivars which are resistant to one or more insects or diseases. Although ornamental plant breeders have not yet taken full advantage of this, it does offer potential for future advancements in pest management.

In the meantime, growers who are having pest problems could improve their pest management program by looking closely at the varieties they grow and how they are affected by pests. Although market demands ultimately decide which varieties are grown, it may be possible to eliminate or reduce the amount of a susceptible variety grown and replace it with a more resistant one.

ENVIRONMENTAL CONTROL

Environmental factors such as light, temperature, humidity, water, soil nutrients can affect not only the plants, but also the insects which feed on them. For example, low temperatures inhibit the development and movement of most insects. Therefore, when treating a pest problem in cold weather, it can improve the effectiveness of a pesticide to increase the temperature for half a day to encourage movement of the insects so that they will more likely come into contact with the chemical. At higher temperatures, insect development is enhanced, but not at the same rate for all insects. Likewise, humidity can play an important role in pest development. Spider mites prefer hot, dry conditions, so increasing the humidity by the use of overhead misting, for example, can help retard the development of this pest. Another example is the effect of light intensity on thrips. During the winter months, thrips are not particularly mobile which is thought to be due more to the low level of light than to low temperatures. This can have implications for monitoring programs where thrips may not be picked up by yellow sticky cards even though they are present and actively feeding in the crop.

The use of environmental controls to help control pests is difficult because of the simultaneous effects on crop production. There are situations where it can be used however, but each case is different and needs to be looked at carefully.

BIOLOGICAL CONTROL

The use of biological control to manage insect pests has become widespread in greenhouse vegetable crops in recent years but has not been used to any great extent in flower crops, although that is beginning to change. Predators or parasites are now available for most of the major greenhouse insect pests, although some have proven to be more successful than others. Insect pests for which biological controls are available include:

Greenhouse whitefly – controlled by the parasitic wasp *Encarsia formosa.*

Two-spotted spider mite – controlled by the predatory mite *Phytoseiulus persimilis.*

Aphids – controlled by the predatory midge *Aphidoletes aphidomyza.*

Thrips – controlled by the predatory mite *Amblyseius cucumeris.*

Leafminer – controlled by the parasitic wasps *Dacnusa sibirica* or *Diglyphus isaea.*

Note: a **parasite** develops within the body of its host and eventually kills it; a **predator** attacks and devours its prey.

Biological control involves more than just releasing the parasites or predators. Growers who use biological control should also include other techniques which have been listed in this publication (monitoring, sanitation, etc.) all of which will contribute to the overall success of control.

For more details about the implementation of biological control or about supplies of parasites/predators, consult your Greenhouse Pest Management Advisor or Horticultural Crops Advisor (page 2).

CHEMICAL CONTROL

Pesticides will remain an important component of our greenhouse pest management programs But for reasons mentioned earlier we need to look very closely at our use of pesticides so that we make the best possible use of those we still have available. There are several important aspects which need to be considered:

1. **Coverage.** It is essential that spray equipment be in good working order and that complete coverage of the plant is obtained. This is especially important for insects such as thrips or whitefly, whose habits make it difficult for sprays to contact them.

2. **Timing.** Different stages of an insect's life cycle require different strategies and/or pesticides when treating them. A good monitoring program will reveal which stage is most prevalent in the greenhouse, and will determine the strategy likely to be most effective. For example, with whitefly, the number of adults caught on a yellow sticky board will fluctuate during the season as the life cycle continues from one stage to the next. Therefore, the optimum time to spray a contact insecticide to knock out the adults will be when the population is high. Similarly, a systemic insecticide will have the best results when larval numbers are at a peak.

3. **Rotation of Pesticide Classes.** If one class of pesticide (eg., organophosphorus, carbamate, or synthetic pyrethroid) is used as the only pesticide for a prolonged period of time, it increases the likelihood of resistance developing to pesticides of that particular class. To reduce the likelihood of this happening, it is recommended that pesticide classes be rotated every few weeks or for a period equal to the generation time of the insect being controlled (eg., for spider mites this may be 1 - 2 weeks, and for whitefly 3 - 4 weeks).

SOIL DRENCHES

Soil drenches are not meant to replace a thorough pasteurization program in the greenhouse. They are useful in preventing recontamination or as an eradicant to eliminate pathogens in the soil or basal parts of the plant.

Some drenches are taken up by the roots of the plant from the soil. In this case, the drenches are systemic and the whole plant is effectively treated against pests. As a general rule, apply 12 L of drench per m^2 of bench area or 300 mL of drench per 15 cm pot. Follow the manufacturer's directions carefully.

COMPATIBILITY OF PESTICIDES

The pesticides recommended in this publication are for individual application to the crop. Before mixing pesticides, read the product label carefully for compatibility statements and contact the supplier.

Avoid mixing EC formulations. Herbicides should never be mixed with fungicides and insecticides; apply with spray equipment reserved for herbicide use only.

PESTICIDE TOXICITY CHART

Common Name	(Trade Name)	LD_{50} (mg a.i./ kg)*	Chemical Family**	Ontario Schedule Number
Insecticides and Miticides				
Acephate	(Orthene)	866	OP	2
Aldicarb	(Temik)	1	Carbonate	5
Bacillus thuringiensis	(Dipel) (Thuricide)	non-toxic	Biological	3
Bendiocarb	(Trumpet)	179	Carbonate	2
Carbaryl	(Sevin)	560	Carbonate	3
Chlorpyrifos	(Lorsban) (Dursban)	135	OP	3
Deltamethrin	(Decis)	535	Syn. Pyr.	2
Demeton	(Systox)	2.5	OP	5
Diazinon	(Diazinon)	300	OP	2
Dichlorvos	(DDVP) Smoke	80	OP	3
Dicofol	(Kelthane)	684	OC	2
Dienochlor	(Pentac)	3160	OC	3
Dimethoate	(Cygon)	215	OP	2
Disulfoton	(Di-Syston)	2.6	OP	5
Endosulfan	(Thiodan)	110	OC	2
Fenbutatin oxide	(Vendex)	2631	Organotin	3
Lindane	(Lindane)	88	OC	2
Malathion	(Malathion)	1400	OP	3
Mevinphos	(Phosdrin)	5	OP	
Naled	(Dibrom)	430	OP	2
Nicotine	(Nicotine) Smoke	50	Botanical	2
Oxamyl	(Vydate)	5	Carbonate	
Oxydemeton-methyl	(Metasystox-R)	75	OP	2
Oxythioquinox	(Morestan)	2500	Carbonate	3
Parathion	(Parathion) Smoke	3.6	OP	5
Permethrin	(Ambush) (Pounce)	4000+	Syn. Pyr.	3
Pirimicarb	(Pirimor)	147	Carbonate	2
Pyrazophos	(Afugan)	500	OP	1
Sulfotep	(Sulfotep)			
	103 Smoke	10	OP	5
Trichlorfon	(Dylox)	560	OP	3
Fungicides				
Benomyl	(Benlate)	10000+	Ben.	3
Captan	(Captan)	9000	Ph.	2
Carboxin	(Vitavax)	3820	Ox.	2
Chlorothalonil	(Exotherm Termil) (Daconil 2787)	10000+	Arom.	
Copper Sulfate			Copper	
Dazomet	(Basamid) (Mylone)			3
Dichloran	(Botran)	10000+	Dicarb.	3
Dinocap	(Karathane)	1190	Dinitro	2
Dodemorphacetate	(Meltatox)	4180	Morph.	3
Etridiazole	(Truban)	1077	Thia.	3
Fenaminosulf	(Lesan)	60	Arom.	2
Ferbam	(Ferbam)	17000+	Dithio.	3
Fixed Copper	(Fixed Copper) (Tricop) (Basicop) (Kocide 101)			

PESTICIDE TOXICITY CHART (Cont'd.)

Common Name	(Trade Name)	LD_{50} (mg a.i./ kg)*	Chemical Family**	Ontario Schedule Number
Folpet	(Phaltan)	10000+	Ph.	2
Formaldehyde	(Formalin) (Standard F) (Tamblyn F)			
Iprodione	(Rovral)	3500	Dicarb.	3
Oxine benzoate	(No-Damp)		Arom.	3
Maneb	(Manzate) (Dithane M22)	6750	Dithio	
Mancozeb	(Manzate 200)		Dithio	
Metalaxyl	Subdue 2G	669	Arom.	2
Quintozene	(Quintozene)	30000	Arom.	3
Thiophanate methyl	(Easout)	10000+	Ben.	3
Triforine	(Funginex)	6000+	EBI	3
Zineb	(Zineb)	5000+	Dithio	3
Growth Regulators				
Daminozide	(B-9)	6810	Organic Acid	2
Chlormequat Chloride	(Cycocel)	478	Quaternary Ammonium	2
Ancymidol	(Arest)	40	Pyrimidine	6

**The relative toxicity of a pesticide may be referred to as its LD_{50}. This is the amount of the active ingredient (a.i.) of the chemical in milligrams used per kilogram of test animal (usually female rats) that kills 50% of the test animals. This is commonly measured as the Acute Oral LD_{50} (above) which refers to the chemical ingested through the mouth or nose. Dermal LD_{50} figures, or skin penetration, are also available. The higher the LD_{50} figure, the less toxic the product is to humans.*

Note: Many pesticides of low acute toxicity are being shown to cause long-term effects in laboratory animals. Users are therefore warned that these could be detrimental to your health. Exposure should be reduced to a minimum by wearing protective clothing. Gloves, goggles and long-sleeved shirt are particularly effective.

***OP = Organophosphorus, OC = Organochlorine, IGR = Insect growth regulator, Syn. Pyr. = Synthetic pyrethroid*

Ben. — benzimidazole
Ph. — phthalimide
Ox. — oxithiin
Dicarb. — dicarboximide
Dinitro — dinitrophenol
Morph. — morphactin
EBI — ergosterol biosynthesis inhibitor
Thia. — thiadiazole
Arom. — aromatic hydrocarbon
Dithio. — dithio carbamate

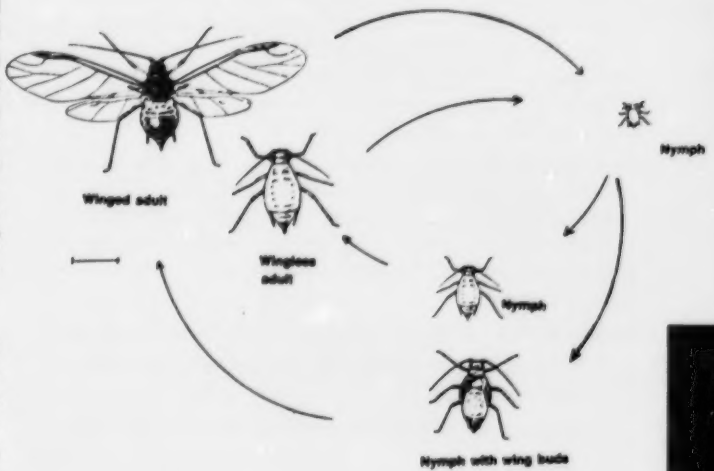
Inclusion of a product in this table does not necessarily imply registration for greenhouse use or registration for a specific crop. Please check the specific label.

MAJOR GREENHOUSE PESTS

Aphids

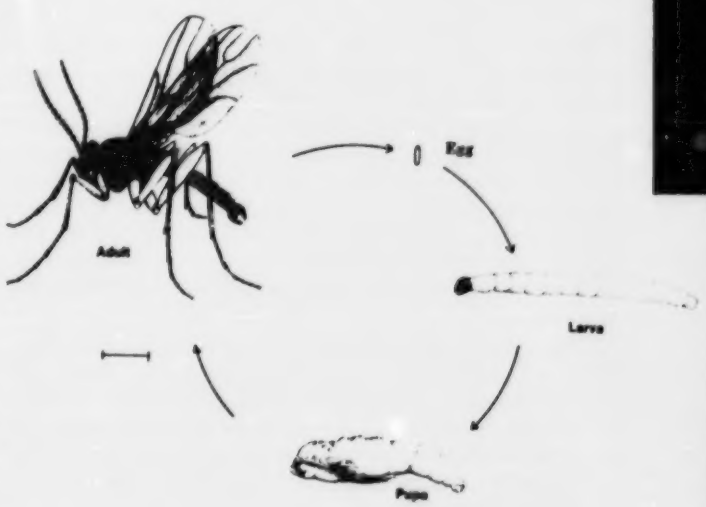
Aphids are small (2-3 mm), soft-bodied insects with long legs and antennae, and a pair of tube-like structures called cornicles projecting from the posterior end. Several species may occur in greenhouses, with color patterns ranging between black, gray, red, yellow and green. Adult aphids are predominantly wingless, although under conditions of high population density, winged adults can also develop. This adaptation is used as a dispersal mechanism which allows aphids to move into a greenhouse from outside, or to rapidly spread within a greenhouse. Female aphids give birth to live young and these offspring can reproduce within 7-10 days. One aphid can give birth to 60-100 young over a 20-day period. Therefore, populations can build up very rapidly. Aphids pierce plant tissue with their mouthparts and suck out the sap, causing deformed leaves and flowers. They also excrete a sticky substance called honeydew which promotes the development of black, sooty mold fungus. Some aphids are capable of transmitting plant virus diseases.

When monitoring for aphids, winged adults can be picked up on yellow sticky boards. For wingless aphids however, it is important to inspect new foliage carefully and regularly to prevent large infestations from developing. Spot treatments of isolated infestations can prevent their spread to the rest of the greenhouse. When infestations occur in the blossom stage, smokes may be more effective and less phytotoxic to plants. If growers wish to use biological control, the predatory midge *Aphidoletes aphidomyza* is available.



Fungus Gnats

Fungus gnats are becoming a serious problem in greenhouses because of the greater use of soilless mixes that have a high organic matter or peat moss content. The gray to black colored adult fly is about 3-4 mm in length with long legs, thread-like antennae and large compound eyes which meet above the base of the antennae. The adult is a weak flier and is frequently observed resting on the media surface in the pot. Each female has a lifespan of about 10 days and lays approximately 150 oval, white eggs in the organic matter of the media. They hatch in 2-7 days, depending on the temperature, producing white larvae which are 4-6 mm long. The larvae have 12 abdominal segments and a distinctive shiny black head. They feed on decaying organic matter in the soil, but also occasionally on the young roots of plants, where they can cause significant damage if present in large numbers. Root feeding can also promote various root rot organisms. The larvae spin pupal cases and remain immobile in the soil for 4-6 days, after which adult flies emerge. As with most insects, fungus gnats become more active and reproduce more quickly at warmer temperatures. The life cycle can be completed in 21 days at 24°C compared to 38 days at 16°C. Sanitation in the greenhouse as well as outside is very important. It is also important to avoid overwatering, since fungus gnats thrive in moist conditions. Soil drenches provide effective control of the larvae.



Chrysanthemum Leafminer

The chrysanthemum or serpentine leafminer, *Liriomyza trifolii* is a major pest of chrysanthemum and gerbera. The adult leafminer is small (approximately 3 mm long) with black and yellow markings on the head and thorax. Adults become active at sunrise.

Scale line = 1 mm

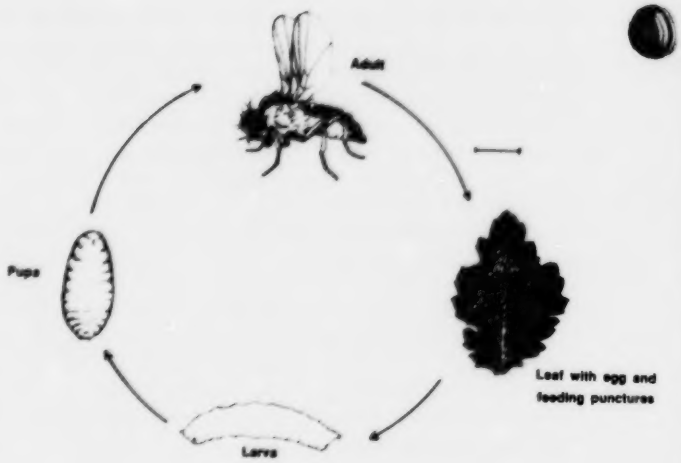
Females feed on soft succulent leaves by piercing the surface with their ovipositor and then lapping the liquid exuding from the leaf. Female flies begin laying eggs 12-24 hours after emergence from the pupa. Approximately 250 eggs are laid during their lifetime of about 30 days. Eggs are laid in about 1 out of 7 leaf punctures (or "stipples"). The optimal temperature for leafminer development is 30°C. At temperatures above or below 30°C, egg production per female declines considerably. After 2-4 days, eggs hatch and the larvae begin feeding (or mining) in the leaf tissue. The larvae mature in 4-7 days (depending on the temperature) in the summer and then cut a hole in the leaf surface and drop to the soil. Pupation takes place within a few hours and these pupae remain in or on the soil for 7-10 days in the summer. From the pupae, a new generation of adult flies emerges. Of course, within any greenhouse there is considerable overlapping of stages of the insect life cycle.

The complete life cycle of the leafminer can be as short as 14 days at 30°C, 24 days at 20°C and 65 days at 14°C. At low soil temperatures (10-12°C) the pupae may remain viable in the soil for up to 90 days. This fact may account for the winter survival of leafminers around the inside perimeter of the greenhouse even though no adult leafminers are evident.

Recommended leafminer control strategy involves making use of:

1. cultural controls (steaming, including walkways, weed control, sanitation);
2. inspection of all new plant material entering the greenhouse;
3. population monitoring (using yellow sticky boards and crop inspection);
4. chemical controls (as needed based on monitoring results).

This insect's ability to develop resistance to insecticides is a major concern. Good pesticide coverage of the crop and rotation of pesticide classes every 2-3 weeks is essential. There are no chemical controls for the egg or pupa at present. The only currently effective treatments are systemic insecticides to kill larvae and contact sprays to kill adults.

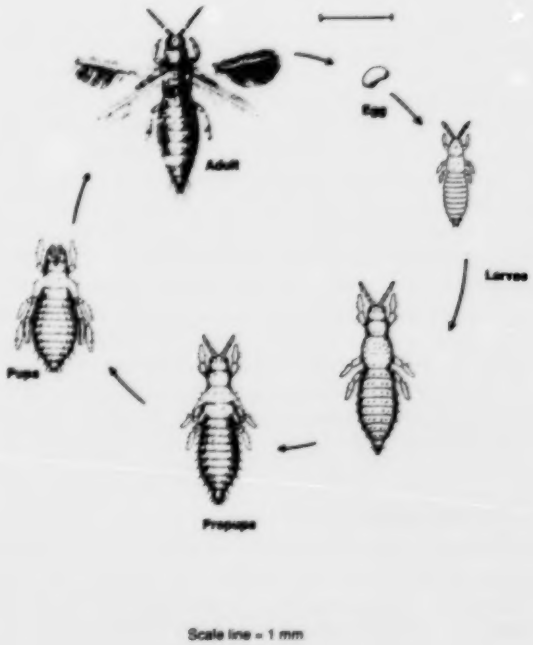


Thrips

Several thrips species are found in the greenhouse including eastern flower thrips, onion thrips, chrysanthemum thrips, greenhouse thrips, and since 1983, western flower thrips (WFT). Thrips are tiny, slender, agile insects about 1.5-3 mm in length when fully developed. Adults vary in color from dark brown or black through to yellow or orange, while young thrips are usually white or yellow with red eyes. The piercing-sucking mouthparts cause white streaked areas on the leaves or translucent spots on the flower petals. Thrips also deposit black fecal material on leaf surfaces.

The life cycle of all thrips is similar. The adult female lays her tiny white eggs inside the leaf tissue. In 5-7 days the eggs hatch and white nymphs emerge which feed on the leaves and petals. They pass through several nymphal stages and a short pupal stage (on the soil or plant) before becoming adults. Adults can live as long as 7 weeks. A new generation may occur every 20-35 days, depending on the temperature.

The presence of WFT in Ontario greenhouses over the past few years poses some special problems. Apart from the damage caused by the insect, it also has the capacity of rapidly developing resistance to pesticides, and it can carry the tomato spotted wilt virus (TSWV) which can have a devastating effect on many common greenhouse crops. The virus has a host range of hundreds of different plant species for which the symptoms of TSWV infection vary widely. Proper diagnosis is therefore essential.



Control of TSWV is difficult, involving removal of infected plants, good weed control and thrips vector control.

Control of WFT can also be difficult because of resistance problems and the thrips habit of feeding deep within the flower head or on developing leaves, which makes it a difficult target for insecticides. Control should be based on a good monitoring program using yellow or blue (both very attractive colors to WFT) sticky boards, and a regular crop inspection. All stages of the thrips can be detected by tapping buds or flowers over a sheet of white paper. When spraying insecticides, good coverage is **essential** because of the cryptic habits of WFT. To control a thrips outbreak, sprays should be used 4-5 days apart for 2 weeks. Chemical classes should be rotated every 3-4 weeks.

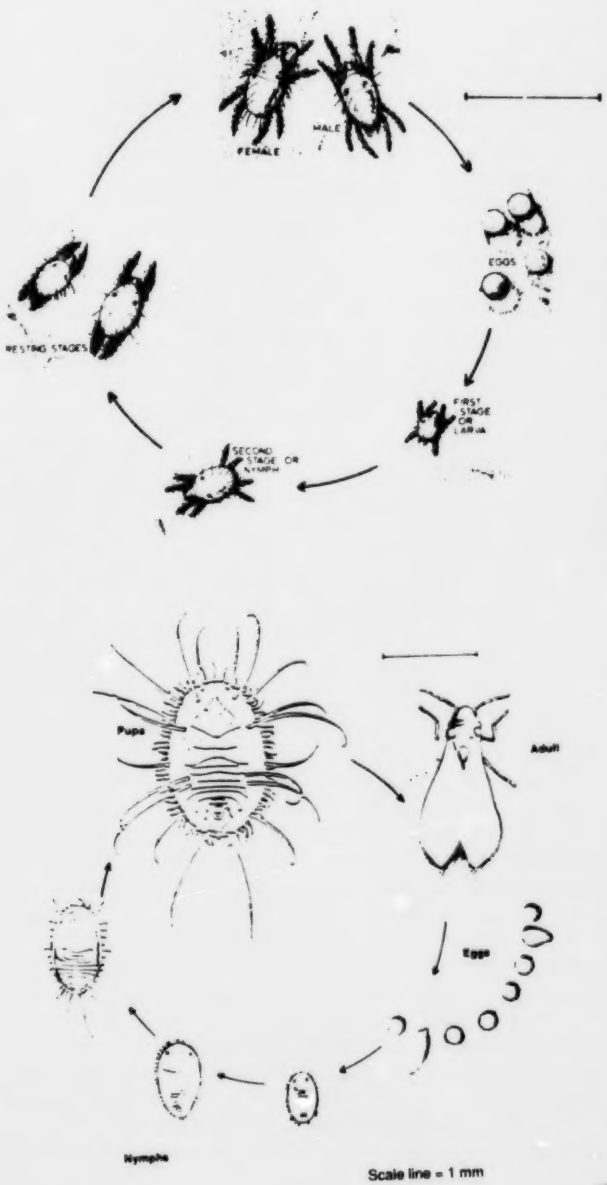
Two-Spotted Spider Mite

The two-spotted spider mite attacks a wide range of greenhouse crops. The eight-legged female adult is approximately 0.5 mm in length with a rounded abdomen. The male can be distinguished from the female by its smaller, narrower body and pointed abdomen. The adults range from pale yellow to orange to brown in color. Close examination of the undersurface of the leaves will show the mites to be very tiny moving dots. The two dark spots on the body of the two-spotted spider mite are the gut contents showing through the transparent body. After mating, each female mite begins laying approximately 6 pearly white eggs per day. Over an average lifetime, 100 or more eggs are laid by a female on the undersurface of the foliage. The newly hatched mites pass through the typical 6-legged larval stage, and 8-legged protonymph and deutonymph stages. The last of these is an immobile resting stage and hence a very difficult target for miticides. The life cycle from egg to adult ranges from 23 days at 15°C to only 7 days at 27°C. Development is most rapid under hot, dry conditions.

All active stages of the two-spotted spider mite feed by piercing the lower epidermis of the leaf with sucking mouthparts. The feeding injury is characterized by the entire leaf appearing light colored or "stippled" on the upper surface. In addition to direct feeding injury, spider mites can produce large amounts of webbing over the foliage and flowers. If infestations are allowed to proceed without control measures being initiated, plants may be killed. Mite populations seem to explode at certain times of the year because the life cycle varies considerably with temperature. Other factors including humidity, plant nutrition and cultivar are also important, and at times can be used to help reduce mite outbreaks.

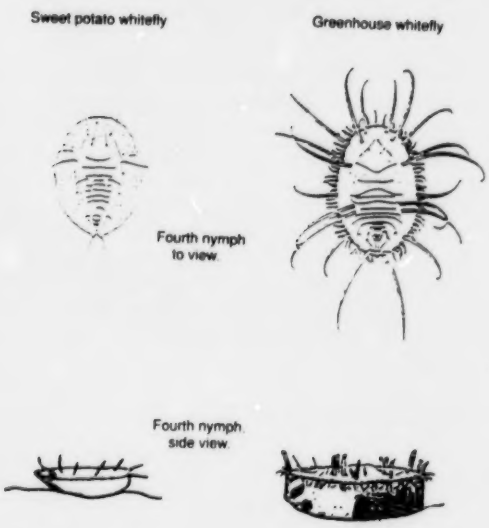
Whiteflies

A serious pest of greenhouses, whiteflies are found on a wide variety of plants and are difficult to control. In general, whitefly adults are small, winged white insects about 1.5-2 mm long. Eggs are laid on the underside of leaves, and are too small to be seen clearly without the aid of a microscope. A female whitefly may lay up to 400 eggs and live as long as 2 months. The nymphs or crawlers which hatch in 5-10 days are flat and scale-like and move over the leaf before becoming immobile. After 3 nymphal stages and 1 pupal stage, the adults emerge. Their piercing-sucking mouthparts allow them to remove sap from the plant. They produce large amounts of honeydew which promotes the growth of black, sooty mold fungus. Old pupal skins and adults may be found on the underside of lower leaves which may have symptoms of wilt. The life cycle can be completed in 4-5 weeks.



Until 1987, there was only one species of whitefly, the greenhouse whitefly (GWF), which concerned growers. In November 1987 the sweet potato whitefly (SPWF) was found for the first time in Ontario. The GWF and SPWF adults look very similar, although there are some differences. The SPWF is a little smaller than GWF, and its body is more yellow in color. At rest, the SPWF holds its wings tent-like above its body, while the GWF holds them flatter and more parallel to the surface on which it is resting. The major diagnostic differences between the two species occur in the pupal stages. The GWF pupa is raised off the leaf surface and is surrounded by a fringe of hairs, whereas the SPWF pupa sits flat on the leaf and does not have a fringe. These features are best seen with a hand lens or microscope.

Granular systemic insecticides have been shown to be effective in controlling whiteflies. Other recommended pesticides are also effective, although both species have shown an ability to develop resistance to many pesticides. A regular monitoring program using yellow sticky boards and crop inspections coupled with judicious use of pesticides and alternation of chemical classes may help to prevent a rapid build-up of resistance, while at the same time providing effective control.



OCCASIONAL GREENHOUSE PESTS

Ants

These are easily recognized by their elbowed antennae and narrow waists. They may be as small as 1½ mm or as large as 6 mm in length. In greenhouses where insect feeding has produced honeydew, ants may be a problem as they are attracted to this sweet substance. Ant trails or nests located in or near the greenhouse should be treated.

Black Vine Weevil

Weevils or snout beetles are characterized by a hard body with a snout and elbowed antennae. This species is dull brown to black, about 9 mm in length with fine ridges along its back. Its larvae are legless grubs, white in color with reddish-brown heads and are found among roots of various bedding plants. Adults actively lay eggs in June, with the larvae feeding on the roots for the rest of the season. The larvae will attack a wide range of plants including roses, geraniums, ferns, gardenias and rhododendrons. Although the adult does not fly, it is able to move to new plantings easily and control measures should be directed against it during late May and June. Inspection of the roots of material introduced to the greenhouse may also prevent an infestation.

Caterpillars

A number of different insects have caterpillar stages which cause damage to greenhouse crops. These include leafrollers, armyworms, cutworms, leaftier and stalk borers. The adult moths of these caterpillars are often attracted to greenhouse lights in the summer, and will then lay eggs which hatch into the caterpillar pest. Armyworms and cutworms feed directly on the foliage of plants and may cause considerable damage before being noticed. Both insects are a dark brown or gray with longitudinal stripes. Cutworms burrow into the soil during the day and come out to feed at night. Infestations of armyworms and cutworms may be brought under control using insecticides recommended for caterpillars.

Stalk borers bore into the stems of plants and as such, can be more difficult to control. If detected early, control should be instituted before the small caterpillars bore into the plants.

For all caterpillars, screening of vents can help prevent entry, and a good weed control program both inside and outside the greenhouse will reduce potential infestation sites.

Cyclamen mite

The cyclamen mite is microscopic in size, being no more than .25 mm in length. It cannot be seen without magnification. The hind pair of legs of the female are thread-like while those of the male are pincer-like. The pale brown female mite deposits approximately 100 eggs, 80% of them female, around the crown of the plant, or along the midrib of unfolded leaves. The mites develop through the six-legged larval stage and quiescent nymphal stage with eight legs similar to the two-spotted mite. The life cycle from egg to adult requires about two weeks but varies depending on temperatures. Usually distorted leaf tissue and/or small blasted or twisted flower buds and flowers are the first damage symptoms. The foliage will often show purplish areas. The cyclamen mites feed around the crown of the plants or in the flower buds. Cyclamen is usually the most seriously injured but this mite is becoming more prevalent in foliage and bedding plants.

Grasshoppers

Grasshoppers are easily recognizable and are occasional invaders of greenhouses. They will feed on almost any vegetation and, in large numbers, can destroy plants. Grass and weeds near greenhouses may allow an infestation of these insects to occur, usually in late summer and fall. Foliar sprays such as Sevin, Malathion, Cygon and Diazinon are effective.

Leafhoppers

Leafhoppers are small, light-colored insects, 3 mm or less in length. They have piercing mouthparts with which they remove plant sap and cause yellowed and mottled leaves. Some species are able to transmit virus-like disease-causing organisms. Infestations in flower crops, such as chrysanthemums, can be detected by these small insects jumping and flying when the foliage is disturbed. Foliar sprays or fog solutions are an effective means of control.

Mealybugs

Two distinct groups of mealybugs may be found in greenhouses. The more commonly encountered **foliage-feeding mealybugs** are white, wax-covered, scale-like insects with piercing mouthparts which remove plant sap. Mealybugs produce large amounts of honeydew. The females (1 to 3 mm long) lay large numbers of eggs in masses of wax. From these eggs hatch (in 5-10 days) active immature mealybugs called crawlers. The nymphs require 6 to 8 weeks to mature into reproductive adults. Damage is caused by the removal of plant sap, the growth of black, sooty mold fungus on the honeydew and the unsightly appearance of the waxy secretions. Mealybugs are a serious greenhouse pest because of the rapid spread of large numbers of crawlers and their ability to exist under bud scales and within leaf axils. Males, present in low numbers, are small, winged insects.

Occasionally, **root feeding** or **subterranean mealybugs** are found within masses of wax on the roots of wilting or yellowing plants. These insects are much like those described above, except that they secrete less wax over their bodies. Again the crawler stage may spread to other plants through contaminated equipment or water leaching through pots. Most infestations result from introduced material that was contaminated. Inspect all plant materials entering the greenhouse carefully for the presence of mealybugs. Systemic granular and drench insecticides are the most effective for controlling these insects.

Midges

These small (1 mm), delicate flies lay eggs in the stems, leaves or flower buds of ornamental plants. The larvae burrow into plant tissue, causing swellings of stems, galls on leaves or collapse of buds. The midge of concern to Ontario rose growers in recent years has been the **rose midge,** which can cause serious losses in a very short period of time. Flower buds first bend or become distorted, turn brown and die. The rose midge is most abundant during the hot summer months, when it enters greenhouses from infestations on outdoor roses. Eggs hatch in approximately 2 days; larvae mature in 5-7 days and drop to the soil to pupate (5-6 days), after which the adult midge emerges and only lives for a couple of days. Therefore, pesticide sprays for the adult stage are ineffective and it is recommended that a foliar spray of the systemic Orthene be applied to control larvae in the base of the buds, as well as a soil drench of Diazinon to control the larvae that fall to the soil surface.

Scale Insects

Scales are minute, wingless insects that are up to 3 mm in length and have piercing-sucking mouthparts and an oval or hemispherical body shape. They secrete a characteristic waxy or scale-like covering over their bodies. The males, which are rare, do have wings. Most individuals are females which lay hundreds of eggs under their immobile scale. When these eggs hatch, small individuals called crawlers migrate to new feeding sites. Damage is caused by the removal of sap from plants, resulting in yellowing and wilting. A number of species have been identified on greenhouse ornamentals in recent years, mainly due to the increased amount of foliar stock being imported from tropical areas. Many of the newer introductions of ferns, palms and ivy plants are quite susceptible to scale infestations. Some of the more common species are described below.

Ivy Scale and Greedy Scale These scales are similar in appearance, being pale and circular in shape with a prominent yellowish nipple in the center. Both attack a wide variety of greenhouse plants such as ivy, palms, *Ficus* and *Fuchsia*.

Fern Scale The shield of this scale resembles an oyster shell and is brown with a lighter terminal nipple. It is usually found on ferns and other foliage.

Brown Soft Scale Female scales are flat, brown and pliable. They have a wide host range and produce large amounts of honeydew which promotes the development of black, sooty mold fungus.

Hemispherical Scale The scale covering on this species is very convex, brown and shiny. Ferns are a favorite host.

Like mealybugs, scales can be initially controlled by eliminating any introduction of infested material. Granular systemic materials and fog solutions are effective in controlling established infestations.

Slugs and Snails

Slugs are dark gray, soft-bodied creatures, varying in length from 1.3-10 cm, which glide over the plants leaving a shiny trail. They eat the foliage of most greenhouse plants, shredding the leaves, and may completely destroy a plant. Slugs are nocturnal and will hide under any cover during the day.

Snails are similar in color and appearance to slugs, except that a snail carries its shell around at all times. The shell varies in color and markings, and may be 1.3-5 cm in diameter. Snails are particularly injurious to seedlings and eat holes in flowers and leaves on many plants, leaving them shiny and tattered. Control of these organisms is obtained by using baited pesticides combining bran bait with metaldehyde. It is important when using metaldehyde to make sure that the toxic baits are inaccessible to children and pets.

Sowbugs/Pillbugs

Sowbugs and pillbugs have gray, flattened, oval bodies up to 13 mm in length and have 7 pairs of legs. They are scavengers, but occasionally may feed on roots and tender parts of plants causing damage to seedlings. They feed at night and hide during the day, preferring dark, moist areas with an abundance of organic matter. Soil sterilization and elimination of decaying plant material and moist areas will aid greatly in preventing any build-up of these organisms.

Springtails

These are tiny, wingless insects that are less than 5 mm long and generally light in color. They are usually found on the surface of moist soil in pots or within the soil. They have a spring-like apparatus at the end of their abdomen which allows them to spring into the air. Springtails feed on decaying organic matter, algae or fungi. They occasionally are numerous enough to be a nuisance. Soil drenches of diazinon will control them.

Symphylans

They have slender, long, white bodies (1-5 mm) with 12 pairs of legs and long antennae. Found in moist soil which contains decaying organic matter, they can eat holes in roots and root hairs. Injured roots become stubby and the plant takes on a stunted appearance.

Tarnished Plant Bug

These bugs, about 6 mm in length, are yellow-brown in color and have piercing mouthparts. The adults and their green nymphs can be serious pests of composites such as chrysanthemums. Eggs are inserted into plant tissue and the small nymphs complete their life cycle in about 4 weeks. They damage new growth causing distortion of foliage and dead or distorted flower buds. They are most active in the late fall and may gain access to the greenhouses from surrounding weedy areas. Foliar sprays and fumigants are effective control measures.

Vertebrate Pests

Rats and mice may be very destructive in the greenhouse. They feed on almost any food source and can cause damage by gnawing and burrowing. Norway rats and field mice are the most common vertebrate inhabitants of greenhouses. Rodenticides, as baits, are available containing such chemicals as chlorophacinone, diphacinone, warfarin, and zinc phosphide. Care should be taken to see that baits are placed in covered stations where pets cannot get them.

Root Nematodes

Plants attacked by root nematodes become stunted and unthrifty. Leaves of some crops, such as roses, may be of abnormal color, suggesting a mineral deficiency. Infested plants are also prone to wilting. Loss of productivity may be the result of a reduction in the number, length and quality of flower stems (or unsightly appearance of potted plants).

Root-Lesion Nematode, *Pratylenchus penetrans* (Cobb). Native to Ontario soils, this pest can attack a wide range of greenhouse floral crops, particularly roses. All stages are thread-like and invisible to the naked eye. Invades the outer layers of young roots, causing small brown-to-black elliptical-shaped lesions which merge to discolor the roots and cause their deaths.

Northern Root-Knot Nematode, *Meloidogyne hapla* (Chitwood). Native to Ontario soils and can attack a great number of floral crops, particularly roses, African violets and geraniums. Early larval stages are thread-like and invisible, while later stages and adults are peanut- to pearl-shaped and just visible when dissected from roots. This nematode invades roots and settles down to cause swellings, knots or galls, and excessive root proliferation. Infested roots do not necessarily become discolored unless attacked by bacteria and fungi.

Dagger Nematode, *Xiphinema diversicaudatum* (Micoletzky). Not native in Ontario, but introduced into greenhouses on plant stocks. Only roses are attacked. The nematode survives in the root crotches of the understock. One of the largest nematodes attacking plants, this 6 mm long, thread-like roundworm can, with care, be seen on the roots. It feeds on young roots from the soil, causing galls not unlike root-knot galls but somewhat larger. These galls are actually curved swelling in the root-tip area, accentuated with the necrosis and shriveling of roots above the galls.

Pin Nematode, *Paratylenchus projectus* (Jenkins). Native to Ontario, and can attack a wide range of greenhouse crops (floral and vegetable); roses especially are infested. All stages of pin nematode are thread-like and invisible to the naked eye. The species is active in both fine-textured (clay) and coarse-textured (sandy) soils. Unlike most other greenhouse nematodes, pin nematode does not enter the roots but feeds at root tips by probing root hairs and surface cells. No specific root symptoms such as galls or lesions will be seen; the general description of top symptoms (above) applies to this species.

Southern Root-Knot Nematode, *Meloidogyne incognita* (Kofoid and White). Not native to Ontario, but has become persistent in the protected environment of greenhouses; dies outdoors over winter. Especially a problem on tomato and cucumber but can also attack a number of floral and foliage crops. Root damage and symptoms differ from northern root-knot nematode by galls being much larger and not showing fine root growths from the galls. Tomato leaves may show phosphorus deficiency (purpling) on the underside or downward curling of leaf edges; affected tomato or cucumber plants wilt readily.

Foliar Nematodes

Foliar symptoms caused by nematodes, unfortunately, are common to a number of disease and deficiency problems and do not necessarily indicate the presence of nematodes. Furthermore, because of the nematode's soil habitat and small size, specific laboratory and microscopic techniques are necessary to confirm their presence and number. There are no effective nematicides registered for use.

Strawberry Bud Nematode, *Aphelenchoides fragariae* (Ritzema Bos). Not native to Ontario, but introduced on plant stock, this nematode is primarily a problem on Begonia but it can attack other greenhouse ornamentals. Invisible and thread-like, it moves in moisture films on stems and leaves. It enters leaves through the stomata and feeds in the inner layers of the leaf, causing small brown spots with water-soaked margins to form on the underside of leaves, which then enlarge and merge, turn dark brown and become visible on the upper surface. Finally, the entire leaf is affected.

Chrysanthemum Nematode, *Aphelenchoides ritzema-bosi* (Shwartz). Not native to Ontario, this nematode is also introduced on plant stock. It is almost identical to the strawberry bud nematode and moves and infests plants in the same manner. Dark brown spots on the underside of leaves are the early symptoms, then the veins become discolored and infested leaves turn brown or black, forming distinct wedge-shaped areas between the veins. Finally the leaves dry, shrivel and hang down along the stems.

MAJOR GREENHOUSE DISEASES

FUNGUS DISEASES

Botrytis Blight (Gray mold). This fungus disease may affect bulbs, stems, leaves and flowers. High humidity caused by crowding the plants, poor ventilation and leaving old leaves and flowers on the plants or soil surface all encourage an outbreak of Botrytis. Symptoms vary from host to host. If the air is very humid, the organism develops a fuzzy gray growth on infected plant parts.

Leaf Spots, Flower Spots and Blights. Spores of the fungi that cause these diseases are wind-borne or splashed about when watering. The leaves must be wet for infection to take place. Avoid overhead watering.

Powdery Mildew. May be recognized by the white powdery growth of the fungus on the leaves, stems and floral parts. The growth is sparse at first but may eventually cover the entire upper surface of the leaves. On some plants, such as roses, the fungal growth may become felt-like. Affected rose leaves frequently develop a reddish discoloration. Generally, the powdery mildew fungus that affects one crop will not affect another. Spores of the fungus are spread by air currents and require high humidity for spore germination and infection of the host.

Wilt. *Fusarium and Verticillium* fungi interfere with the water-conducting tissues in the plant. Leaves may wilt, become yellowish and eventually turn brown. Plant growth and bloom production are reduced. Plants may be killed. The fungi persist in the soil and gain entrance through the roots. The most common means of infection would be propagation of infected stock or planting susceptible plants in infested soil.

Damping-off of Seedlings. Wet soil, poor sanitation, poor ventilation, high humidity and thick strands of seedlings are ideal conditions for damping-off fungi. There are 3 types of damping-off that can cause major problems in bedding plants.

Rust. Rust fungi attacking one host do not attack another. They may be identified by the masses of orange to dark red or brown spores that can be seen when pustules on leaves or stems break open. Rust may occur on carnation, chrysanthemum, geranium, snapdragon and other plants. Rust spores are spread by air currents and by splashing water. They require water on the leaf to germinate and infect the plant, and may travel long distances in infected cuttings.

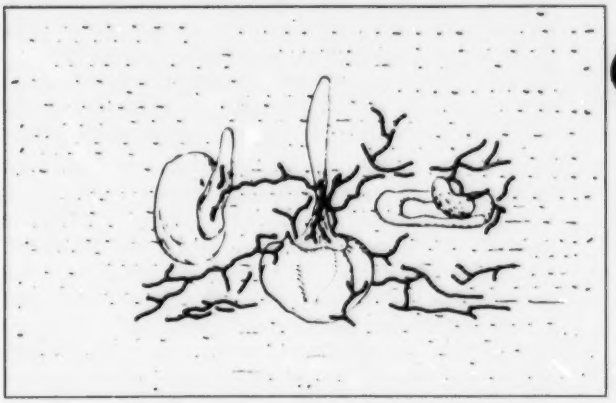
Crown and Root Rots. All the fungi described below are soil inhabitants.

Pythium and *Phytophthora* fungi cause a rotting of the roots and crowns of many plants. The lower part of the leaf and petioles of such plants as Gloxinia and African Violet and stems of other plants have a water-soaked appearance. Eventually the entire plant will rot off at the ground level.

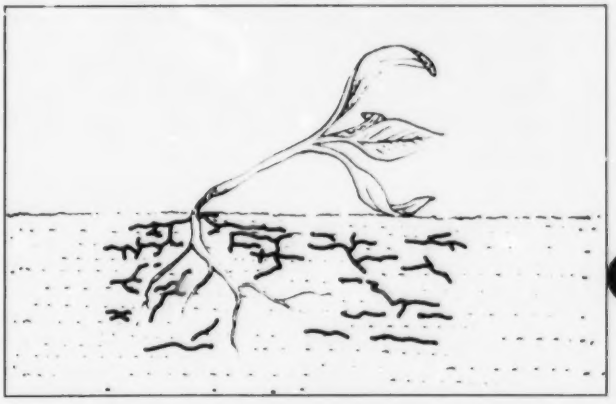
Rhizoctonia and *Fusarium* fungi cause a brown cankering of the below-ground stem and roots of infected plants.

Thielaviopsis causes a severe rotting of the roots of infected plants. The affected areas are more black in color than brown.

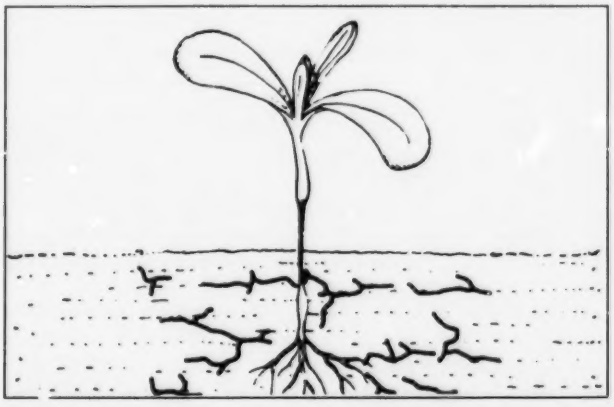
Sclerotinia causes a rot near the soil line, and can usually be identified by the presence of thick white mycelium on the soil surface.



1. Preemergence Damping-Off. The seeds are killed before germination, or soon after. The young plants never emerge from the soil. This loss is often blamed on poor seed.



2. Postemergence Damping-Off. Most growers are familiar with this stage. The stem is invaded near the soil surface. The seedling wilts, the stem collapses and the plant topples over. Other variations of postemergence damping-off include top rot or top damping-off, and root rot.



3. Wire-Stem Damping-Off. Seedlings that have been hardened off may be attacked by damping-off organisms. Stems are partially girdled, discolored and wire-like in appearance, hence the name wire stem. Infected plants are stunted and eventually die.

VIRUS DISEASES

Viruses are disease-causing agents that multiply only within living plant cells. They tend to spread throughout the host plant. Depending on the virus, they are spread by sucking insects, such as aphids and leafhoppers or by tools, handling, etc. Some viruses are spread with cuttings. Vein banding, flecking, ring spots, mosaic (irregular areas of dark and light green on the leaf), or growth abnormalities may develop in the leaves, depending on the particular virus. Some viruses cause stunting.

BACTERIAL DISEASES

Control of bacterial diseases is very difficult, but fortunately they are not as common as fungus diseases. Bacterial infections may appear as wilts, stem and root rots, leaf spots, galls and fascination of plant parts. Good cultural practices and extreme care in sterilization procedures will reduce the chance of bacterial infection. Fixed copper sprays are a reasonable control for bacterial diseases *but* phytotoxicity may be a problem.

FUNGICIDAL ACTIVITY — FLOWER CROPS

	Botrytis	Fusarium	Leaf Spots[1]	Powdery Mildew	Rusts	Pythium	Phytophthora	Rhizoctonia	Sclerotinia	Thielaviopsis
Benlate	R	R	X	R				X	X	X
Botran	X									
Captan	X		X			R				
Daconil 2787	X	X	X	X	X		X	X		
Easout	R	R	X	R						
Exotherm Termil	X									
Ferbam			X		X					
Funginex				X						
HRC Liquids systemic					X[2]					
Karathane				X						
Meltatox				X						
No Damp								X		
Quintozene								X	X	
Rovral	X							X	X	
Subdue						X	X			
Sulfur			X	X						
Truban						X	X			
Vitavax Captan						X		X		
Zineb, Maneb			X		R					

[1] *Check label for specific leaf spot control*
[2] *Carnation rust only*
R *Indicates possible resistance*
X *Indicates effective control of disease*

GROWTH REGULATORS

The use of growth regulators has become an important cultural tool in the production of greenhouse flower crops. They influence different processes in the plant, such as root formation, flower induction, vegetative growth, etc. The following section will concentrate on limiting vegetative growth (height control).

1. Factors to Consider

(a) Plant vigor. A healthy, vigorous plant is more apt to tolerate the stresses of growth regulators. For instance, the height reduction by growth retardants such as B-9, Cycocel and A-Rest will be more severe on weak plants. A-Rest applied to Easter lilies with poor root development can cause undue loss of bottom leaves. A dehydrated plant will be more susceptible to growth regulator damage than a turgid plant. For all applications, the root system of the plants should be well established.

(b) Cultivar response. The growth habit of different cultivars may determine the concentration and the number of applications of growth regulators. A tall-growing pot mum such as the Princess Anne series would generally require a higher concentration of growth retardants than the shorter cultivars like Mandalays.

(c) Environment. Plants grown under low light may require less growth retardant than those under high light intensity. Therefore, the concentration may have to be adjusted accordingly for winter and summer production. A-Rest is reported to be ineffective on Easter lilies if plants are lighted and given long days. Growth regulators should not be applied during the high heat period of the day (higher than 22°C). Preference should be given to applications during the evening when the solution will not dry up rapidly or be affected by the sun.

(d) Stage of plant growth. Growth regulators are generally more effective when applied to young and vigorous plants. A-Rest applied to Easter lilies that are less than 10 cm in height may reduce bud count, delay flowering and severely stunt plant growth. When applied too late, A-Rest will produce lilies with a palm-tree effect or bracts that are too small (poinsettias). Early application may also affect the development of some (bottom) bracts on poinsettias and chrysanthemums. This is more pronounced with the higher rates or more effective growth regulators.

(e) Dosage and coverage. It is extremely important that the correct concentration of the chemical be applied. Accurate measurement can only be made with proper weighing instruments and/or measuring containers. For Cycocel and B-9, recommendations are based on the concentration of the liquid solution being applied, whereas for A-Rest the recommendation is for drenching and expressed as total active ingredients per plant (per pot).

1 milligram of ingredient X per litre of water = (1,000 g) = 1 ppm X

1 ppm	=	.0001%	= 1 mg/L
10 ppm	=	.001%	= 10 mg/L
100 ppm	=	.01%	= 100 mg/L
1,000 ppm	=	0.1%	= 1,000 mg/L
10,000 ppm	=	1.0%	= 10,000 mg/L

Therefore, a 2,500 ppm B-9 concentration is a 0.25% solution containing 2,500 mg/L of active ingredient.

A-Rest contains 0.0264% active ingredient, or 264 ppm ancymidol. For 5 ppm, one needs a 1:53 dilution or 19 mL/L of water.

(f) Read the label. There are sometimes different formulations on the market and it is your responsibility to read the label and use the material accordingly. It may also give an indication about the need of a spreader sticker.

(g) Growth regulators should be stored in a similar manner as other pesticides, namely in a *cool, dry* and *dark* site. Do not let the temperature drop below 0°C. Shelf life is at least 2 years. Some growth regulators may not be stable for a long time after being mixed with water. Therefore, to prevent breakdown, mix just prior to use.

2. Methods of Application

(a) Drench. Some growth regulators are systemic within the vascular system (Cycocel and A-Rest). Drenching may provide a better means of distributing the chemical within the plant and therefore more control. Treatment is precise but generally requires more labor. It is important that the roots be well developed prior to application; this is critical for A-Rest drench on Easter lilies. Make sure that plants are not under water stress, since injury can occur if plants are on the dry side. It may be wise to water the plants in late afternoon and apply the treatment the following morning. Apply adequate amounts of solution to wet the entire root mass. The following is the recommended drench volume for various pot sizes:

Pot size cm	Volume of drench solution mL
10	90
13	120
15	180
20	240
25	300

(b) Spray. Application is less laborious; however, uniform coverage of the foliage is critical. Plants should be turgid to prevent foliage damage. Keep foliage dry for 12-24 hours after spraying to prevent washing the chemicals from the leaves. Most chemicals contain wetting agents; however, a spreader may be required in some cases to obtain more uniform distribution of the chemical on the foliage and decrease the possibility of leaf damage. A rate of 10-20 L of spray/100 m^2 will generally give good coverage. To prevent excessive wastage of the chemicals, arrange the plants as close as possible without undue crowding. It is **very important** that spraying equipment is operating properly. It is desirable to keep a separate sprayer for this job and clean the sprayer after each application to safeguard against unnecessary damage from other chemical residues.

Pot size cm	Volume of spray solution mL
5.5	1
10	3
12.5	6
15	10
20	20

3. Number of Applications

Naturally, a **single** application of a drench or spray is the most economical; however, it is a "one-shot" treatment and vulnerable to mistakes.

A **split** application using one-half the suggested concentration applied twice 1-2 weeks apart allows for more flexibility and reduces the chances of damage to plants. It also allows time to monitor plant growth, and repeated applications can be made accordingly.

4. Estimating Final Plant Height

Floriculture researchers have found the final height of chrysanthemums and poinsettias can be predicted. This finding can be very useful in determining the effectiveness of a growth retardant and whether additional applications are necessary. Four weeks following the start of short days, chrysanthemum and poinsettia reach approximately one-half of their final height at maturity. By measuring the plant height from the pot rim 4 weeks following short days and doubling this height, you have an estimation of final height. If at 4 weeks the doubling height gives a final estimated height that is still **too tall,** another application of growth retardant can be given on that day. This will cause a further retardation in growth, thus a more desirable plant will be produced. Growers should try this system on a trial basis to determine whether it can be incorporated into their cultural program as a growth-monitoring technique.

5. Directions for Mixing Chemicals

1. READ THE LABEL.

2. The final volume should include the growth regulator which is to be added. The first step is to add the chemical, then make up to final volume with water. If the direction reads 60 mL B-9/L, first add 60 mL of B-9 in a suitable measuring container, then add water to the 1 L mark. **Do not add 60 mL B-9 to 1 L of water.** Remember that the final solution including B-9 should be 1 L.

3. Don't add wetting agent (spreader) if the label informs that it is already present in the solution.

4. Read the label to see if the material is sufficiently stable for storage after mixing. It is best to mix chemicals before each application to ensure proper activity of the chemical.

5. Don't mix growth regulators with **any** chemicals. The application of growth regulators is too critical to warrant mixing with other chemicals. Don't take chances to save time. Take time to do the best job of mixing and applying growth regulators.

GROWTH REGULATOR RECOMMENDATIONS

PLANT	GROWTH REGULATOR	CONCENTRATION OF ACTIVE INGREDIENT	METHOD OF APPLICATION
AZALEAS	B-Nine SP (85%) (height control)	2,500-3,500 ppm (0.25-0.35%)	spray
	Cycocel (11.8%)* (height control)	2,000 ppm (0.20%)	spray
BEDDING PLANTS	B-Nine SP (85%) (height control)	2,500-5,000 ppm (0.25-0.50%)	spray
CHRYSANTHEMUMS (pot mums)	B-Nine SP (85%) (height control)	2,500-5,000 ppm (0.25-0.50%)	spray
	A-Rest (0.0264% ancymidol) (height control)	2-8 ppm (0.125-0.5 mg/15 cm pot)	drench for 2 ppm (120 mL/15 cm pot)
CHRYSANTHEMUMS (cut mums)	B-Nine SP (85%) (height control)	2,500 ppm (0.25%)	spray the top one-third of the foliage
GERANIUM (seed)	Cycocel (11.8%)* (height control)	2,000-3,000 ppm (0.2-0.3%)	soil drench
HYDRANGEAS	B-Nine SP (85%) (height control during forcing)	2,500-5,000 ppm (0.25-0.50%)	spray to wet foliage
LILIES	A-Rest (0.0264% ancymidol) (height control)	0.25 mg/15 cm pot	drench 180 mL of 1.3 ppm solution/15 cm pot
POINSETTIAS	B-Nine SP (85%) (height control)	5,000-7,500 ppm (0.50-0.75%)	spray
	A-Rest (0.0264% ancymidol) (height control)	2-8 ppm (0.125-0.5 mg/15 cm pot)	drench
	Cycocel (11.8%)* (height control)	1,500-3,000 ppm (0.15-0.30%)	spray or drench

** Make adjustment in mixing rates when using Cycocel Extra.*

FOR GREENHOUSE FLORICULTURE CROPS

MIXING RATES (METRIC)	TIME OF APPLICATION	COMMENTS
3.0-4.2 g/L of water	After last pinch when shoots are 2.5 cm long (6 weeks after pinching). Apply early morning.	Increases short day response and early bud formation. Don't let solution drip on medium.
20 mL/L of water	Apply during short day treatment twice, with 1-week interval.	Can produce medium-hard plants, slight chlorosis and/or uneven flowering. Also used to promote early flowering on some varieties.
3.0-6.0 g/L of water	Two to four weeks after transplanting when plants are 3-5 cm in diameter. May be repeated 4 weeks later.	Good for most bedding plants but not effective on snapdragons, celosia, coleus, pansies, pelargonium (geranium), carnation, cleome, convolvulus and gomphrena.
3.0-6.0 g/L of water	Apply when shoots are 2-4 cm long. May be repeated 3 weeks later.	Use the low concentration to the pinched crops and the high concentration to the single stem pot mum. Spray to wet foliage.
For 2 ppm mix: 8 mL/L of water	Apply just as root system spreads over outside soil ball.	For 2 ppm dilute 1:128. Entire soil must receive uniform application. A-Rest contains a wetting agent.
3.0 g/L of water	Two days after disbudding or 4 weeks after shade initiation.	Do not mix B-9 with any other pesticides.
For 2,500 ppm mix: 21 mL/L of water	Three weeks after transplanting.	May cause some marginal leaf burn. Induces earlier flowering.
3.0-6.0 g/L of water	Apply first spray between 2 and 3 weeks (4-5 leaf stage); second spray one week later.	Can apply after buds are visible if necessary.
For 1.3 ppm mix: 5 mL/L of water	Apply when lilies are 7-15 cm tall. Do not apply between January 23-February 7, as bud count may be reduced.	Can also be used as a spray. Spray may affect flower bud count. Not very effective if bark medium is used.
6.0-9.0 g/L of water	Spray when shoots are approximately 5 cm tall.	Do not add any wetting agent. Late application may delay blooming.
For 2 ppm mix: 8 mL/L of water	Treat plant at pinch to 4 weeks after pinch, or 8 to 12 weeks before finishing.	Do not add a wetting agent. Use 125-150 mL of solution to a 15 cm tall.
13-25 mL/L of water	Apply when shoots are 2-4 cm tall.	Application later than October 10 may delay flower development. Spraying twice with one-half the recommended concentration is more effective than once with the high concentration.

PESTICIDE INJURY TO FLOWER CROPS

Although greenhouse insecticides have been selected and formulated to avoid plant injury, damage can still occur under some conditions. No insecticides are safe on all plants under all conditions, although wettable powders are generally less injurious than liquid formulations. In many cases, a material may be safe when applied to dry foliage but can cause injury when used on wet foliage. Here is a list of possible hazards.

1. **Cygon** will injure many chrysanthemum varieties.
2. **Daconil 2787** may damage open blooms (Exacum).
3. **DDVP** (Vapona, dichlorvos) is injurious on some chrysanthemum varieties, especially Shasta and Pink Champagne. Also damages some varieties of snapdragons, tradescantia, some crassulas, ferns and some rose varieties. Crop should be dry when applied.
4. **Diazinon** is not for use on gardenias, poinsettias, hibiscuses, stephanotis, pileas, hydrangeas, cyclamen foliage.
5. **Dibrom** injures some ornamentals, including some chrysanthemum varieties, and can cause flower damage to cucumbers.
6. **Lindane** injures hydrangeas, poinsettias.
7. **Lorsban** is known to be phytotoxic to azaleas, geraniums, coleus, roses, some chrysanthemum varieties (eg, marbles), camellias, poinsettias, oxalis and variegated ivy. Caution should be taken when applying this product to exotic or tropical plants.
8. **Malathion** should not be used on fern, petunia and crassula, orchid, sweetpea, cucurbit, saintpaulia, gloxinia, rieger begonia and some carnation and rose varieties.
9. **Manzate 200** may cause stunting when used in repeated soil drenches on cyclamen, exacum and poinsettia, particularly when soil is dry.
10. **Metaldehyde** has reportedly damaged Cattleya and Phalaenopsis orchids when applied as sprays and dusts.
11. **Meta-systox R** damages lilies, rieger begonias, geraniums and chrysanthemum varieties Hurricane, Iceberg, Whitetop and Pennant.
12. **Morestan** has damaged rose varieties (cv. Samantha).
13. **Nicotine** may injure lilies and some chrysanthemum varieties. Do not smoke on open blooms of snapdragons, geraniums or African violets.
14. **Orthene** is injurious to African violets, poinsettias, gloxinia and many varieties of geraniums.
15. **Parathion** may prove harmful to gardenias, hydrangeas, crassulas, ferns, kalanchoes, asters, cyclamens, tender foliage plants, rieger begonias and succulents. May cause leaf drop on roses if used within 7 days of sulfur, particularly in the fall or winter.

CAUTION — Parathion may have a bleaching effect on the open blooms of all flower crops.

16. **Pentac Aquaflow** causes some foliage damage on chrysanthemums. Do not apply to open blooms, especially hydrangea.
17. **Pirimor** should not be applied to Icecap, Goldcap and related varieties of chrysanthemums.
18. **Safers Insecticidal Soap** should not be used on poinsettias, maidenhair fern sweetpea or nasturtium.
19. **Sevin** (carbaryl) should not be used on Boston ivy or Virginia creeper.
20. **Tedion** (tetradifon) may cause injury to some roses, especially White Butterfly and Cinderella.
21. **Thiodan** (endosulfan) may injure some geranium varieties. Emulsifiable concentrate has injured Bonnaffon Deluxe and some other chrysanthemum varieties. There have been reports of injury to cineraria, gardenia, gloxinia, poinsettia, rose, African violet and pothos. If plants are well watered and not stressed, there is less likelihood of damage.

PEST AND DISEASE CONTROL FOR FLOWER CROPS*

PROBLEM	RECOMMENDATION BY TRADE NAME	FOR 1000 L	OTHER
	AFRICAN VIOLET (Saintpaulia)		
Aphid	Thiodan 4 EC or Thiodan 50% WP	1.25 L 1.0 kg	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	35 mL/ 100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Mealybug	DDVP Smoke Fumigator		1/300 m^3
	Lorsban 25% WP	3.84 kg	
	Dibrom Insecticide		10 mL/100 m^3
	Insecticidal Soap	20 L	
Thrips	Lindane Smoke Fumigator or Lindane 25 WP	1.0 kg	1/300 m^3
Two-Spotted Spider Mite	Insecticidal Soap Kelthane 18.5% EC or Kelthane 35% WP	20 L 1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP	2.0 kg	
	Captan 80% WP	1.5 kg	
	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
Crown Rot	Subdue 2 G		125-250 g/m^3 - preplant incorporated 125-1000 g/100 m^2 - surface application - see directions
	Truban 30% WP	175-625 g	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

* *The recommendations in this section (page 29 to 49) are for flower crops only.*

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		AZALEA	
Aphid	Thiodan 4 EC or Thiodan 50 WP	1.25 L 1.0 kg	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Leafroller	Dipel	0.63-1.25 kg	
Thrips	Diazinon 50 EC or Diazinon 50 WP	1.0 L 1.0-1.5 kg	
	Lindane Smoke Fumigator or Lindane 25% WP	 1.0 kg	1/255 m^3
	Malathion 50 EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
Two-Spotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Pentac Aqua Flow	650 mL	
	or Pentac 50% WP	620 g	
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Whitefly	Thiodan 4 EC or Thiodan 50 WP	1.25 L 1.0 kg	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Pounce 384 EC	275 mL	
	Insecticidal Soap	10 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Damping-off	Truban 25 EC	300-630 mL	
Petal Blight	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	BEDDING PLANTS		
Aphid	Pirimor 50% WP	500 g	
	Nicotine Smoke Fumigator		1/300 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Insecticidal Soap	20 L	
	Trumpet 80 W	.75-1.0 kg	due to diversity of types, test a few plants first
Two-Spotted Spider Mite	Pentac Aqua Flow or Pentac 50 WP or Pentac Fog Solution	650 mL 620 g	35 mL/100 m^3
	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Whitefly	Ambush 50 EC	200 mL	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Pounce 384 EC	275 mL	
	Insecticidal Soap	10 L	
	Parathion Smoke Fumigator		1/300 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50 WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		10 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Exotherm Termil Smoke Fumigator		1/300 m^3
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Rovral 50% WP	1 kg	
Damping-Off	Truban 30% WP Truban 25 EC	250-375 g 240-300 mL	
	Quintozene 20% WP or Quintozene 75% WP		4-6 kg/100 m^2 1.0-1.25 kg/100 m^2
	No-Damp	10 L	
	Rovral 50% WP		2 g/5 L/m^2
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	BEGONIA (Rieger)		
Aphid	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Mealybug	Malathion 50% EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Lorsban 25% WP	3.84 kg	
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		10 mL/100 m^3
	Insecticidal Soap	20 L	
Thrips	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 1.0 L	
	Lindane Smoke Fumigator or Lindane Fog Solution or Lindane 25% WP	 1.0 kg	1/255 m^3 35 mL/100 m^3
	Malathion 50% EC	2 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	. 75-1.0 kg	1.25 kg/ha drench

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Two-Spotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20-25 L	
Whitefly	Ambush 50 EC	200 mL	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Pounce 384 EC	275 mL	
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Botran 75% WP	925 g	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
Root Rot (Cuttings)	Lesan 35% WP	0.50-1.0 kg Apply to 100 m^2	
	Truban 30% WP	250-375 g	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
		BULB CROPS	
Tulip Bulb Aphid	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Dibrom Insecticide		10 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
	Daconil 2787	2.5 L	
Blight	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Daconil 2787	2.5 L	
Crown Rot	Truban 30% WP	175-625 g	
		CALCEOLARIA	
Aphid	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Thrips	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
Two-Spotted Spider Mite	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Whitefly	Insecticidal Soap	10 L	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide Pounce 384 EC	 275 mL	10 mL/100 m^3
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 50% WP or Captan 80% WP	2.0 kg 1.5 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		CARNATION	
Aphid	Diazinon 50% EC or Diazinon 50% WP	1.0 L 1.0-1.5 kg	
	Nicotine Smoke Fumigator		1/300 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 (under 20°C) 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Thrips	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
	Diazinon 50% WP or Diazinon 50% EC or Diazinon Fog Solution	1.0-1.25 kg 1.0 L	 35 mL/100 m^3
Two-Spotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP	650 mL 620 g	
	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
Alternaria Leaf Spot	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	1.2 kg/100 m^2
	Daconil 2787	2.5 L	
Botrytis	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	
Fusarium Stem Rot	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Leaf Spot	Daconil 2787	2.5 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Rhizoctonia Stem Rot	Subdue 2 G		125-250 g/m^3 - preplant incorporated 125 - 1000 g/100 m^2 - surface application - see directions
	Quintozene 20% Dust or Quintozene 75% WP		4 kg/100 m^2 1.25 kg/100 m^2
	Vitavax-Captan 30% WP	350 g	
	CHRYSANTHEMUM		
Aphid	Pirimor 50% WP	500 g	
	Diazinon 50% WP or Diazinon 50 EC or Diazinon Fog Solution	1.0-1.5 kg 1.0 L	35 mL/100 m^3
	Nicotine Smoke Fumigator		1/300 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Metasystox-R 240 SC	2 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	[2] Temik 10 G		550 g/100 m^2
	Insecticidal Soap	20 L	
Caterpillar	Thuricide HPC	5 L	
	Dipel	1.0-1.25 kg	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Leafminer	Afugan 30 EC*	1.5 L	
	Diazinon 50% WP or Diazinon 50 EC	1.0-1.5 kg 1.0 L	
	[2]Temik 10 G		550 g/100 m^2
	Ambush 50 EC	200 mL	
Leaftier	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 1.0 L	

**Temporary registration restricted to chrysanthemum growers.*
[2]Minimum period before reentry is 48 hours.

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Tarnished Plant Bug	Malathion 50% EC	1.88 L	
Thrips	Decis 2.5 EC	0.7-1.0 L	
	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	or Diazinon 50% WP or Diazinon 50 EC	1.0-1.5 kg 1.0 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
Two-Spotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP	650 mL 620 g	
	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Metasystox-R 240 SC	2.0 L	
	[2] Temik 10 G		550 g/100 m^2
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Whitefly	Ambush 50 EC	200 mL	
	Insecticidal Soap	10 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	[2] Temik 10 G		550 g/100 m^2
	Pounce 384 EC	275 mL	
Leaf Spot	Daconil 2787	2.5 L	
	Captan 7.5% Dust or Captan 50% WP	 2.0 kg	1.2 kg/100 m^2
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Ascochyta Ray Blight	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Zineb 3.9% Dust		
	Daconil 2787	2.5 L	

[2]*Minimum period before reentry is 48 hours.*

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	
	Botran 75% WP	925 g	
	Rovral 50% WP	1.0 kg	
Root Rot	Truban 30% WP Truban 25 EC	250-375 g 240-300 mL	
	Subdue 2 G		125-250 g/m^3 - preplant incorporated 125-1000 g/100 m^2 - surface application - see directions
		CINERARIA	
Aphid	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Two-Spotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Insecticidal Soap	20-25 L	
	Vendex 50% WP	0.5-1.0 kg	
Whitefly	Thiodan 50 WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Pounce 384 EC	275 mL	
	Insecticidal Soap	10 L	
Thrips	Decis 2.5 EC	0.7-1.0 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Botran 75% WP	925 g	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
		CYCLAMEN	
Aphid	Nicotine Smoke Fumigator		1/300 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
Two-Spotted Spider Mite	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	1.2 kg/100 m^2
	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
Fusarium Root Rot	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		EXACUM	
Two-Spotted Spider Mite	Pentac Aqua Flow	650 mL	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Rovral 50% WP	1.0 kg	
		FOLIAGE PLANTS	
	Note: Due to the diversity of foliage plants and the lack of factual information on varietal damage, these recommendations are for **TRIAL USE ONLY.**		
Aphid	Pirimor 50% WP	500 g	
	Malathion 50 EC	2.0 L	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		10 mL/100 m^3
Brown Soft Scale	Malathion 50% EC	2.0 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
Mealybug	Lorsban 25% WP	3.84 kg	
	Malathion 50% EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Two-Spotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP or Pentac Fog Solution	650 mL 620 g	 35 mL/100 m^3
	Kelthane 35% WP or Kelthane 18.5% EC	750 g 1.25 L	
	Vendex 50% WP	0.5-1.0 kg	
Whitefly	Ambush 50 EC	200 mL	
	Trumpet 80 W	.75-1.0 kg	
	Pounce 384 EC	275 mL	
	Insecticidal Soap	20 L	
Root Rot (Cuttings)	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	1.2 kg/100 m^2
	Truban 30% WP Truban 25 EC	190-750 g 300-630 mL	
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Daconil 2787	2.5 L	
Botrytis	Rovral 50% WP	1.0 kg	
Leaf Spots and Blights	Daconil 2787	2.5 L	
		GERANIUM	
Aphid	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Pirimor 50% WP	500 g	
	Nicotine Smoke Fumigator		1/300 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Mealybug	Trumpet 80 W	.75-1.0 kg	
	Malathion 50% EC	2.0 L	
	Dibrom Insecticide		10 mL/100 m^3
Two-Spotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Insecticidal Soap	20-25 L	
	Vendex 50% WP	0.5-1.0 kg	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Thrips	Decis 2.5 EC	0.7-1.0 L	
Whitefly	Ambush 50 EC	200 mL	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Pounce 384 EC	275 mL	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Botran 75% WP	925 g	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	Foliage only
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
Damping-Off	Truban 25 EC	300-630 mL	
Stem and Root Rots	Subdue 2 G		125-250 g/m^3 - preplant - incorporated 125-1000 g/100 m^2 - surface application - see directions
Rust	Daconil 2787	2.5 L	Foliage only
	Zineb 3.9% dust		
		GERBERA	
Two-Spotted Spider Mite	Pentac Aqua Flow	650 mL	
	Kelthane 35% WP or Kelthane 18.5% EC	750 g 1.25 L	
Thrips	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	 1/255 m^3 35 mL/100 m^3
	Diazinon 50% WP or Diazinon 50% EC or Diazinon Fog Solution	1.0-1.25 kg 1.0 L	 35 mL/100 m^3
Whitefly	Insecticidal Soap	10 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		GLOXINIA	
Aphid	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Thrips	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 1.0 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	1/255 m^3 35 mL/100 m^3
Two-Spotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Insecticidal Soap	20 L	
	Vendex 50% WP	0.5-1.0 kg	
Root, Stem Crown and Tuber Rot	Subdue 2 G		125-250 g/m^3 - preplant - incorporated 125-1000 g/100 m^2 - surface application - see directions
Botrytis	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	
		GYPSOPHILA	
Two-Spotted Spider Mite	Pentac Aqua Flow	650 mL	
	Kelthane 35% WP or Kelthane 18.5% EC	750 g 1.25 L	
Thrips	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 1.0 L	
	Lindane 25% WP or Lindane Smoke Fumigator or Lindane Fog Solution	1.0 kg	1/255 m^3 35 mL/100 m^3

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		HYDRANGEA	
Aphid	Trumpet 80 W	.75-1.0 kg	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	
Two-Spotted Spider Mite	Kelthane 18.5 EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Rovral 50% WP	1.0 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Daconil 2787	2.5 L	on foliage only
Leaf Spots	Daconil 2787	2.5 L	
Rust	Daconil 2787	2.5 L	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 kg 2.5 kg	
		LILY (Easter)	
Aphid	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Sulfotep Smoke Fumigator or Lindane Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	20 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Two-Spotted Spider Mite	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	
Thrips	Decis 2.5 EC	0.7-1.0 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Rovral 50% WP	1.0 kg	
	Daconil 2787	2.5 L	
Root Rot	Truban 30% WP	175-625 g	
		POINSETTIA	
Brown Soft Scale	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Malathion 50% WP	2.0 kg	
	Insecticidal Soap	20 L	
Mealybug	Malathion 50% EC	2.0 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Lindane 25% WP	1.0 kg	
	Parathion Smoke Fumigator		1/300 m^3
	Dibrom Insecticide		10 mL/100 m^3
Two-Spotted Spider Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Pentac Aqua Flow or Pentac 50% WP or Pentac Fog Solution	650 mL 620 g	 35 mL/100 m^3
	[2]Temik 10 G		550 g/100 m^2
	Vendex	0.5-1.0 kg	

[2]*Minimum period before reentry is 48 hours.*

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Whitefly**	Ambush 50 EC	200 mL	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP	1.0 kg	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	[2]Temik 10 G		550 g/100 m^2
	Pounce 384 EC	275 mL	
Botrytis	Daconil 2787	2.5 L	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Rovral 50% WP	1.0 kg	
	Botran 75% WP	925 g	
Damping-Off Stem Rots	Subdue 2 G		125-250 g/m^3 - preplant incorporated 125-1000 g/100 m^2 - surface application - see directions
Rhizoctonia Stem Rot	Quintozene 20% Dust or Quintozene 75% WP		4 kg/100 m^2 1.0-1.25 kg/100 m^2
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Root Rot	Quintozene 20% Dust or Quintozene 75% WP		6 kg/100 m^2 0.98-2.73 kg/100 m^2
	Subdue 2 G		125-250 g/m^3 — preplant incorporated 125-1000 g/100 m^2 - surface application - see directions
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	

[2]*Minimum period before reentry is 48 hours.*
***Avoid pesticide application after bract color, as damage may occur.*

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
		ROSE	
Aphid	Pirimor 50% WP	500 g	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Nicotine Smoke Fumigator		1/300 m^3
	Orthene 75% SP	850 g	
	Insecticidal Soap	20 L	
Brown Soft Scale	Malathion 50% EC	2.0	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	10 L	
Leafroller	Dipel	1.0-1.25 kg	
	Thuricide HPC	5 L	
	Orthene 75% SP	850 g	
Midge	Orthene 75% SP	850 g	
	Parathion Smoke Fumigator		1/300 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg (soil drench) 1.0 L	
Thrips	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	Diazinon 50% WP or Diazinon EC	1.0-1.5 kg (soil drench) 1.0 L	
	Orthene 75 SP	850 g	
Two-Spotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP	650 mL 620 g	
	Kelthane 18.5 EC or Kelthane 35% WP	1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
	Insecticidal Soap	20 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Whitefly	Ambush 50 EC	200 mL	
	Insecticidal Soap	10 L	
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	Orthene 75% SP	850 g	
	Pounce 384 EC	275 mL	
Black Spot	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Daconil 2787	2.5 L	
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Zineb 3.9% Dust		
Powdery Mildew	Meltatox 40% EC	2.5 L	
	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Botrytis	Rovral 50 WP	1.0 kg	
	Daconil 2787	2.5 L	
	SNAPDRAGON		
Aphid	Pirimor 50% WP	500 g	
	Nicotine Smoke Fumigator		1/300 m^3
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Insecticidal Soap	20 L	
Cyclamen Mite	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	

PROBLEM	RECOMMENDATION	FOR 1000 L	OTHER
Thrips	Diazinon 50% WP or Diazinon 50% EC	1.0-1.5 kg 1.0 L	
	Trumpet 80 W	.75-1.0 kg	1.25 kg/ha drench
	Lindane Smoke Fumigator or Lindane Fog Solution		1/255 m^3 35 mL/100 m^3
Two-Spotted Spider Mite	Pentac Aqua Flow or Pentac 50% WP	650 mL 620 g	
	Insecticidal Soap	20 L	
	Kelthane 18.5% EC or Kelthane 35% WP	1.25 L 750 g	
	Vendex 50% WP	0.5-1.0 kg	
Whitefly	Thiodan 50% WP or Thiodan 4 EC	1.0 kg 1.25 L	
	DDVP Smoke Fumigator or DDVP Fog Solution		1/300 m^3 35 mL/100 m^3
	Trumpet 80 W	.75-1.0 kg	
	Dibrom Insecticide		10 mL/100 m^3
	Sulfotep Smoke Fumigator or Sulfotep Fog Solution		1/300 m^3 35 mL/100 m^3
	Insecticidal Soap	10 L	
Botrytis	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
	Exotherm Termil Smoke Fumigator		1/300 m^3
	Captan 7.5% Dust or Captan 50% WP or Captan 80% WP	 2.0 kg 1.5 kg	
	Daconil 2787	2.5 L	
	Rovral 50% WP	1.0 kg	
Powdery Mildew	Benlate 50% WP + Manzate 200	500 g 2.5 kg	
Stem Rot	Truban 25 EC Truban 30% WP	240-300 mL 175-625 g	

GREENHOUSE VEGETABLES

Crop Protection

Note: The information on the following pages (pages 50 to 61) pertains to greenhouse vegetable crops only. For flower crop protection information, refer to pages 29 to 49. It is important that you DO NOT interchange the pest control recommendations between the two sections.

Regulations of Health and Welfare Canada have established the amounts of insecticides and fungicides that are permitted to remain on or in food crops at time of harvest. To avoid exceeding such amounts, follow recommendations exactly. Residues of an unregistered pesticide on a marketed crop, or excessive residues of a registered pesticide may lead to its seizure, and prosecution. Safe intervals between the last application of a material and harvest are given in days and enclosed in brackets after each material mentioned in the text. Where 2 or more materials are mixed, the interval from treatment to harvest must be that of the material having the longest interval.

All pesticide chemicals should be treated as poisons and should be stored in a safe place, well away from children, pets, livestock, etc. (see Pesticide Storage, page 6).

Pesticides may cause plant injury under certain conditions. Where possible, it is best to test pesticides, and especially pesticide mixtures, on a few plants first to check the plant safety factor under your own conditions. Read the warnings on the label and consult the manufacturer's information regarding compatibility before using a mixture of 2 or more recommended pesticides.

Many pesticides degrade quite rapidly, especially in alkaline water. Mix only in quantities that can be applied within 1-2 hours (see page 8).

Also read:
Precautions With All Pesticides, page 4
If Accidents Occur, page 4
Pesticide Poisoning, page 4
Blood Tests for Those Applying Pesticides, page 5
Protective Clothing When Using Pesticides in Greenhouses, page 5
Relative Hazards to Humans of Recommended Pesticides, page 4
Reentry to Treated Areas, page 6

Note: Over a period of time, an insect or disease may become resistant or immune to certain pesticides. Therefore, where possible, it is advisable to make alternate applications of the recommended pesticides. Notify your OMAF Pest Management Advisor (page 2) if you suspect a material is no longer effective.

The recommendations which follow have been reviewed by the Ontario Pesticides Advisory Committee.

All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Such use can result in seizure of the crop.

Integrated Pest Management

Integrated Pest Management (IPM) may be defined as the combined use of suitable strategies in a compatible manner for suppressing pest (insect, mite and disease) incidence in order to obtain favorable economic production. The concept of IPM encompasses all aspects of production from sowing of seeds through production to after harvest clean-ups; as a result, strategies adopted are quite varied in approach. IPM aims to reduce or eliminate dependence on pesticides and the accompanying negative consequences, including toxic residues, harmful effects of long-term exposure, environmental pollution, etc. Major strategies employed in IPM systems include the following:

Crop Monitoring. A good pest manager has to be continually vigilant in order to detect any potentially harmful factors early enough to take preventitive action. Daily crop inspections should be carried out during routing operations (e.g., examination of leaves during pruning). Colored, sticky traps placed in the crop at an adequate density, will attract aphids, whiteflies, fungus gnats, and thrips. These are all attracted to yellow traps, however, thrips seem to favor blue ones. Traps should be placed along the upper portion of the crop. The number of traps varies with the type of crop. Recommendations range from 1 trap per 50-100 plants to 25 traps per acre. As a rule, the more traps there are placed, the greater the likelihood of detecting those insects that are attracted to them. Such traps not only indicate species of insects present, but can also show the level of infestation present in the crop.

Daily inspection of traps and the plants themselves is a vital exercise that must be carried out as a safeguard against pest outbreaks.

Biological Control. The use of living organisms such as insects, mites, nematodes, viruses, fungi and bacteria to control pests (insects, mites, diseases) constitutes biological control. At present, commercially produced biocontrol agents are available for all the major greenhouse insect and mite pests (see Table 1), but not yet for the diseases. Successful use of biologicals hinges upon timely introduction, use of adequate rates and proper placement. For instance, early introduction at first sign of the pest is usually recommended using high enough rates to achieve acceptable control. Placement of larger numbers of the parasite/predator at locations of higher pest populations increases chances of containing any further spread.

Caution is required in the use of pesticides when biocontrols are used, since most are harmful to them. Application of just one harmful pesticide can prevent further use of biocontrol agents for an extended period of time. See Table 2.

Cultural Control. The underlying principle of cultural control is to provide conditions most favorable to the crop and least favorable to the pest. It aims at protecting the crop by suppressing or minimizing the incidence of disease and by delaying insect/mite build-up. Major cultural control measures include:

1. *Environment Manipulation.* For example, temperature and ventilation control to prevent "dewpoint," the stage at which moisture condenses on the crop and induces development of diseases such as gummy stem blight and gray mold.
2. *Sanitation.* See page 9.
3. *Timing of Planting.* Avoid sowing or replanting when another crop is in close proximity. To prevent infection and infestation of the new plants, allow sufficient time between crop removal and replanting to reduce chances of pest carry over.
4. *Provision of Adequate Spacing.* Overcrowded plants are less vigorous and provide moisture conditions favorable to many diseases.

IF THE CROP YOU WANT TO SPRAY OR DUST IS NOT LISTED ON THE LABEL, DO NOT USE THE PESTICIDE.

5. *Optimum Nutrition.* Maintain correct pH and optimum nutrient levels to produce sturdier plants that are better able to withstand pest attack. Pay attention to potassium:nitrogen ratios and calcium levels. These factors are related to plant resistance.
6. *Use of Resistant Varieties.*
7. *Maintenance of Optimum Root Conditions.* Low soil temperatures favor development of root diseases. Overwatering or low moisture conditions cause stress, and can result in flower and fruit drop, and physiological diseases such as blossom end rot.

Physical Control. Such methods require the use of equipment or measures that affect the pests directly. Some common physical measures include:

1. *Soil Pasteurization.* This is used for sterilization of soil and other media prior to replanting (see page 10).
2. *Screening.* Screens at vents and other openings help to prevent insects and other wind-borne pests.
3. *Traps.* Traps available for greenhouse pests consist of sticky colored strips and cards. See Crop Monitoring, page 9.

Chemical Control. An IPM program uses selective chemicals that control the pest without adversely affecting its natural enemies. If such specific chemicals are not available, use pesticides with the least toxicity or persistence and apply to individual plants or groups of plants with the highest pest infestation. Generally, pesticides should be used only as a last resort because of the many undesirable consequences and hazards associated with their use.

Rockwool, Peat Bags, Nutrient Film Technique

At the present time, there is a trend toward production of greenhouse vegetables in artificial media (substrates) such as rockwool, peat bags and nutrient film (NFT). From a crop protection viewpoint, these production systems have several advantages such as:

1. Elimination of soil drainage problems which favor disease development.
2. Warmer temperatures in the root zone, reducing disease problems associated with cold soil.
3. Prevention of nematode damage. Artificial media are nematode free, thus negating the need for sterilization (page 10).

NOTE: If such media are re-used for more than one crop, sterilization between crops may be necessary. Growers who have had persistent soil disease or nematode problems may wish to consider substrates. It is advisable to study all the available literature and to consult with one or more greenhouse owners who have switched to a substrate system. OMAF Publication 526, *Growing Greenhouse Vegetables*, contains sections on growing in substrates.

TABLE 1. SUMMARY OF BIOCONTROL AGENTS FOR PRINCIPAL GREENHOUSE PESTS

Pest	Biocontrol Agent
Whitefly *(Trialeurodes vaporariorum)*	*Encarsia formosa* (parasite)*
Spider Mite *(Tetranychus urticae)*	*Phytoseiulus persimilis* (predator)**
Western Flower Thrips *(Frankliniella occidentalis)*	*Amblyseius cucumeris* (predator)
Aphids: Various species	*Aphidius matricariae* (parasite) *Aphidoletes aphidimyza* (predator)
Fungus Gnat *(Bradysia and Corynoptera* spp)	*Hypoaspis* sp. (predator) N.B. Will also contribute to reduction of thrips population

**Parasite: kills its host (pest) by living on or in its body, and therefore depends on it for completion of its development.*

***Predator: feeds on its prey (pest) by catching them, but otherwise lives independently of them.*

TABLE 2. REPORTED EFFECTS OF REGISTERED PESTICIDES TO BIOLOGICAL CONTROL AGENTS[a]

Pesticide	Encarsia formosa	Phytoseiulus persimilis	Amblyseius cucumeris	Aphidoletes aphidimyza
Ambush	H (>56)	H (>56)	H (>56)	H (>56)
Benlate	S	H (7)	H (7)	S
Botran	S	S	S	S
Dibrom	H (14)	H (14)	H (14)	H
Dipel	S	S	S	S
Dithane M-22/ Maneb	H	S	S	S
Dithane M-45/ Manzate 200	S	S	S	S
Ferbam	S	S	S	S
Ins. Soap	H	H	H	—
Kelthane	H (4)	H (14)	H (4)	S
Lannate	H (>42)	H (>42)	H (>42)	—
Malathion	H (>30)	H (14)	H (14)	H
[b]Micro Niasul/ Kumulus S	S	S	H	S
Parathion	H (>56)	H (7)	H (>56)	H
Rovral	S	S	—	—
Thiodan	H (20)	H (7)	H (14)	H
Vendex	S	S	S	S
Zineb	S	S	—	—

[a]*Numbers in parentheses refer to residual toxicity to biological agent in days where data available. S = Safe; H = Harmful. "—" means no data is available, so presume toxic unless otherwise proven.*

[b]*This table serves only as a guide to the possible effects of these pesticides on the biocontrol agents. Variations in toxicity may occur under varying conditions.*

Tomato Seed Treatment

Hot Water Treatment. This treatment is recommended especially for control of bacterial canker, when seed infection is suspected. Many seed companies routinely hot-water treat their greenhouse tomato seed before packaging. If this has not been done, place tomato seed in a loose cheesecloth bag and soak in water at 50°C for 30 minutes. The treatment may be carried out at 54°C for 30 minutes if the seed if planted within a few days. Use an accurate thermometer and stir the water frequently during treatment. Spread seed out to dry immediately after treatment.

Chemical Treatment. To destroy tomato virus on the mosaic seed coat, treat tomato seed a day or two before sowing for 15 minutes in a solution of trisodium phosphate (100 g in 1 L of water). Rinse seed thoroughly with warm water. Spread out to dry on clean paper or plastic.

Seed Protectant. To protect all greenhouse vegetable seedlings against soil-borne damping-off fungi, treat the seed with protectant fungicide (e.g., thiram or captan), before sowing. Follow manufacturer's direction.

Ornamental and Fruit Plants in Vegetable Greenhouses

Ornamental and fruit plants grown in corners of greenhouses, mostly for the enjoyment of the grower and his family, constitute a serious source of infestation of vegetable crops for insects, nematodes and diseases. Most of them, such as oleander, fig and grape, are perennial, so the soil can never be sterilized and insects and diseases survive on them between vegetable crops. They should be completely removed to a separate greenhouse well away from propagating and producing vegetable houses. By the same token, hanging baskets of ornamentals should never be placed in the same house as vegetables because of the risk of soil splash transferring nematodes and diseases to the crop below.

Cucumber Disease Control

For general descriptions of cucumber diseases, see Agriculture Canada Publication 1684, *Cucumber Diseases*. Also, OMAF Publication 526, *Growing Greenhouse Vegetables* (see page 64).

Bacterial Wilt
A sudden wilt of cucumber caused by bacteria that are carried in the gut of cucumber beetles. Infection is transmitted by beetle feeding. Crops planted in July, August, and September are most likely to be attacked, especially if there are curcurbit crops, such as melons, squash, pumpkins, etc., growing in fields nearby. See Cucumber Beetle Control, page 55.

Basal Stem Rot and Root Rot
Before planting, sterilize the soil with steam or use a soil fumigant (see Soil Sterilization, page 10). Transplant into a well prepared, warm soil (20°C). Apply a ferbam spray and avoid cold water shock as described on this page for late damping-off.

Black Root Rot
Diseased plants tend to wilt on sunny days, but may recover at night. With the aid of a hand lens, examine the roots of such plants for small, longitudinal black lesions. If black root rot is discovered at an early stage, mound the bases of the stems with a soil-peat mixture to encourage new root growth. The mound should cover the area of the first leaf scar. Where black root rot is a recurring problem, consider:

1. artificial media;
2. grafting to the disease-tolerant rootstock Cucurbita ficifolia, for crops to be grown in soil beds.

Soil pasteurization with steam (page 10) is the most effective control in soil beds. Ensure that soil bed temperatures are adequate (20°C) before planting.

Cucumber Mosaic Virus
Many seedless varieties are susceptible to cucumber mosaic, especially when it occurs in conjunction with certain soil-borne fungi (e.g., *Pythium*). The virus is spread by aphids and by workers handling the plants.

Control aphids. Remove infected plants immediately. Isolate areas where infection occurs. Do not prune, sucker, etc., in these areas prior to working in non-infected areas. Disinfect pruning knives, etc., in trisodium phosphate solution of 100 g trisodium phosphate to 1 L water.

Damping-off
Use only vigorous transplants that show no sign of disease. Transplant into a well prepared, warm soil (20-21°C) that has been steamed or fumigated (page 10). Be sure that toxic gases from fumigants have disappeared. Determine this by setting a few plants in the soil at least 3 days before planting the greenhouse. Immediately after transplanting, spray the base of the plants with Ferbam 76% WDG, 1.5 kg/1000 L of water. Avoid cold water shock to young plants by pre-heating the irrigation water to 21°C.

Damping-off caused by *Pythium spp.* can be a serious problem in artificial media such as rockwool or peat, especially when reused for second or third crops. Before reusing such media, it should be allowed to dry out for aeration, and pasteurized (page 10).

Downy Mildew
Occasionally a problem in August-September planted seedless cucumber crops. Reduce humidity and provide good air circulation. Apply a little heat on cool nights to prevent moisture condensation on the leaves. If the disease appears, spray thoroughly with:

Benlate 50 WP 550-850 g plus 2.25 kg Manzate 200 (5 days); or

Maneb 80% WP 2 kg (3 days).

Gray Mold (Botrytis)
Often becomes serious in spring (March-May) and in autumn (September-November). Reduce humidity, provide good air circulation, and ventilate freely. Provide adequate heat on cool nights. Remove old leaves and suckers carefully, leaving no snags or tears. Take away all prunings and plant debris from infected crops. Diseased areas on stems may recover if scraped and covered with a fungicide paste of Ferbam 76% WDG (1 day) or Rovral 50% WP (2 days).

Spray at weekly intervals until the disease is checked with:

Ferbam 76% WDG	1.5 kg (1 day); or
Rovral 50% WP	1 kg (2 days).

NOTE: 1. Alternate between the recommended fungicides to delay resistance build-up.

2. The above materials will also help control gummy stem blight.

Read and follow label directions when applying any pesticide.

Gummy Stem Blight
Provide adequate heat and do not allow the crop to sweat at night. Avoid overhead irrigation. This disease is readily spread by fingers, tools, and splashing water. Strict sanitation must be practiced at all times. Fruit which is suspected of having gummy stem blight should not be included in marketing consignments.

At first appearance of the disease, spray at 7-10 day intervals with:

Benlate 50 WP 550-850 g + 2.25 kg Manzate 200 (5 days)

Fungicides used to control gray mold (Botrytis) also help control gummy stem blight. Alternate between the recommended fungicides to delay resistance build-up.

Leaf Spots (Alternaria, Anthracnose)
At first appearance, spray with:

Maneb 80% WP, 750 g (5 days), or

Benlate 50 WP, 550-850 g + 2.25 kg Manzate 200 (5 days).

Postharvest Breakdown
Under certain conditions, seedless cucumbers will deteriorate very quickly after harvest. Several diseases may be involved, including gummy stem blight and scab. Breakdown is most frequently seen when several unseasonably cool nights alternate with hot, sunny days in later summer months. It also occurs when storage periods after picking are prolonged, especially at improper temperatures and in poorly ventilated areas. There is no one method of preventing this condition, but especially in the summer when you have hot, sunny days and below normal temperatures at night, take care to:

1. Prevent disease outbreaks.
2. Avoid water condensation on the cucumbers (i.e. "sweating") by providing a little heat at night.
3. Avoid overloading, which weakens the plants and causes unhealthy cucumbers that lack turgidity.
4. Harvest cucumbers with a sharp knife, leaving a 1-2 mm stem on each fruit.
5. Avoid tearing, fruit bruises, cuts and abrasions.
6. Maintain the temperature for marketing and storing between 10-15°C and ideally at 12°C. The relative humidity of the storage area should be between 85 and 95%.
7. Avoid accumulation of ethylene gas in the storage areas by keeping cucumbers away from apples, tomatoes, and other fruits and by adequate ventilation.

Powdery Mildew
Follow strict sanitation practices (page 9). Grow seedlings in an area that is completely isolated from greenhouses where the previous season's crops are still growing, OR delay starting new seedlings for several weeks after destroying all plants, seeds, weeds, and debris from the previous crop.

When powdery mildew appears, spray at weekly intervals as required with:

Kumulus S 80% dispersable granular sulfur 1.2 kg (1 day); or

Micro-Niasul 92% wettable sulfur 3/4-1 kg (1 day).

CAUTION: A build up of sulfur residue resulting from repeated applications of spray may injure cucumber leaves, especially if greenhouse temperatures rise above 29-32°C. Repeated sprays are seldom needed under such temperatures, but if they are, remove old residues by syringing the plants with water before re-spraying.

A late infestation of powdery mildew may occur during the cucumber harvest season in April, May or June. It is possible to obtain at least partial control by fogging with a high pressure system, or by syringing the plants with water, using moderate pressure. This, of course, increases the humidity which may cause further development of other diseases. Therefore, ventilate as much as possible so the plants will dry off before the sun goes down.

A few European seedless cucumber cultivars have a degree of tolerance to powdery mildew. Trial plantings may be advisable.

Pseudo Yellow Virus
A disease of seedless cucumber crops that is spread by the greenhouse whitefly. Symptoms are chlorotic yellowing between the veins of older leaves and interveinal yellow spotting on intermediate leaves. Upper foliage may remain unaffected during the early stages. Diseased plants become less productive. There is no known method of control except to control whitefly (page 5). Beets, several species of weeds, and lettuce are known to be alternate hosts. Therefore, the practice of alternating leaf lettuce crops with seedless cucumbers may not be advisable. Also see Sanitation (page 9).

Scab
Most likely to become a problem in single-layer plastic houses, especially under conditions of cool nights, when water forms on the cucumbers, followed by sunny days. Cucumber scab may contribute to postharvest breakdown. Maintain night temperatures at or above 18°C. Provide good ventilation and air circulation to reduce humidity, especially in plastic greenhouses.

Sprays applied for leaf spot (this page) will also help control cucumber scab.

Watermelon Mosaic Virus
The disease was first reported in Canada in 1975, and appears to be spreading in southwestern Ontario. Alfalfa and certain weed species are alternate hosts. It can be transmitted by aphid.

Control is the same as that for Cucumber Mosaic Virus (page 53).

Wilting
In the absence of disease or nematodes, wilting often occurs during April and May when warm sunny days follow prolonged cloudy periods. The most common causes of this wilting are unfavorable temperatures, high salts and inadequate root systems. Plants usually recover within a few weeks, but frequently some of the lower leaves, and occasionally a few of the plants, die. Mound the base of affected plants with soil (preferably muck) to cover the first joint to promote new root growth and hasten recovery. Syringe with water on very hot days to reduce the amount of wilting. To encourage adequate root growth on young crops, remove all stem fruit to waist level (about 1 m)

Sudden Wilt of Seedless Cucumber
This disorder is similar to wilting, but unlike wilting, the root system does not show signs of major decay, and the plants are less likely to recover. Total collapse of the entire plant may be very sudden. All factors that may contribute to sudden wilt are not understood, but investigations have shown a combination of cucumber mosaic virus and the damping-off fungus, *Pythium spp.* is frequently involved. All practices that help prevent damping-off (page 53) and cucumber mosaic virus (page 53) should be carefully followed.

Cucumber Insect Control

Aphids
1. Prevent aphids from entering the greenhouse by screening vents and doors.
2. Eliminate weeds and other non-crop growth within the greenhouse.

Amounts of material are per 1000 litres of water unless otherwise stated.

3. Maintain a weed-free area of at least 3 m adjacent to the greenhouse range.
4. Restrict movement of personnel and equipment from infested to non-infested areas.
5. Aphid predators will provide adequate control under optimum conditions (see Integrated Pest Management and Table, page 51).
6. Apply one of the following control measures if aphids are noted on the lower surface of cucumber leaves:

   Dibrom 10 mL/100 m^3 on heating pipes (1 day). CAUTION: Repeated applications, or single applications at above the recommended dosage may injure seedless cucumber blossoms.

   Thiodan 50% WP 1 kg or Thiodan 4 EC 1.25-1.5 L (1 day)

   Parathion smokes (1 day)

   Nicotine smokes (7 days)

Cucumber Beetle

This insect spreads bacterial wilt disease (page 53). Prevent the beetles from entering greenhouses by screening all ventilators and doors, especially during late spring, summer and fall when the beetles are prevalent. If additional control is needed, consult your Greenhouse Vegetable Pest Management Advisor regarding effective insecticides (page 4).

Greenhouse Whitefly

1. Sticky yellow boards or tapes will trap whitefly adults. This gives an early indication that whiteflies are present. (See Crop Monitoring, page 9).
2. **Biological Control.** The parasitic wasp *Encarsia formosa* deposits its eggs within whitefly eggs or larvae, and kills the developing whiteflies by growing within their bodies. Introduce parasites when adult whiteflies are first noticed, and before they become abundant. You must learn to recognize the very small, black and yellow adult parasites. Monitor your crop closely for indications of parasite activity. A parasitized whitefly nymph turns black and an adult parasite emerges later on. Allow pruned leaves to remain in the greenhouse for several days to ensure emergence of the parasites from the pupal cases. Whiteflies will decline in numbers when the parasite completes several generations, and both whiteflies and parasites will stay at low numbers.

For information on obtaining parasites, and for assistance in recognizing the small adult wasps, consult your Greenhouse Pest Management Advisor (page 4). Also, see page 64, and read OMAF Factsheet, *Using Parasites for Whitefly control on Greenhouse Vegetables* Agdex 290/613.

3. **Chemical Control.**
   1. Dibrom 10 mL/100 m^3 on heating pipes (1 day). CAUTION: Repeated applications, or single applications above the recommended dosage may injure seedless cucumber blossoms.
   2. Thiodan 50% WP 1 kg or Thiodan 4 EC 1.25-1.5 L (1 day). NOTE: Many strains of whitefly are resistant to Thiodan; others may develop resistance after repeated applications.
   3. Parathion smokes (1 day). Generally effective only against light infestations and in small greenhouse areas.
   4. Permethrin, e.g., Ambush 500 EC-200 mL (1 day), or Pounce 384 EC-260 mL (1 day). NOTE: Resistance has developed in many areas.

The above materials mainly control adults. Repeat applications at 5-day intervals to prevent egg laying by newly emerged adults.

Root-Knot Nematode

The species usually attacking greenhouse cucumbers is the southern root knot nematode.

Before planting, steam the soil or use a soil fumigant (page 10) according to label directions. When the crop is grown in artificial media, nematodes are less likely to be a problem. However, rockwool or peat bags should be sterilized before re-use.

Thrips

1. See Cultural Controls #2-4, under Aphids, page 51.
2. Thrips predators will provide a good measure of control under optimum conditions. See Table 1, page 51.
3. The insecticide Lannate has registration for western flower thrips control on greenhouse cucumbers. Use 22 mL of the formulated product per 100 L of water (3 days). Make 3 applications at 5-7 day intervals. NOTE: Read precautions on product label before using. Wear full protective clothing. Apply in a closed greenhouse; ensure that the greenhouse remains closed for 2 hours or longer after treatment. Ventilate the greenhouse for an additional 1 hour or longer before reentry.
4. Controls as listed for greenhouse whitefly (this page) may also provide a measure of control for thrips.

Two-Spotted Spider Mite

As soon as the first mite injury is seen, remove and destroy all infested leaves. Then begin biological and/or chemical control measures on these and the surrounding plants.

1. **Biological Control.** The biological control program uses the predator *Phytoseiulus persimilis* which feeds on all stages of the two-spotted mite. This predator is also a mite, but it does not feed on plants, and can be distinguished by its orange color. The predators, which are slightly larger than the two-spotted mite, should be placed on the mite-infested cucumbers at a rate of 5 per plant. Examine the plants regularly to check that predators are established. They can be moved on a piece of leaf to other newly infested cucumber plants. Also see Integrated Pest Management, page 50.
2. **Chemical Control.** Spray must be applied to cover both upper and lower leaf surfaces. Mites multiply very rapidly at temperatures over 20°C, so April, May and June are critical months. Recommended miticides are:
   1. Vendex 50 W, 500 g - 1 kg (5 days). Also helpful where biological control is used because Vendex does not harm the predators. Efficiency is increased when a spreader sticker is added.
   2. Kelthane AP 35% 750 g (3 days).
   3. Dibrom 10 mL/100 m^3 on heating pipes (1 day). CAUTION: Repeated applications, or single treatments at the above recommended dosage may injure seedless cucumber blossoms.

NOTE: Do not rely on one product for a prolonged period of time. Alternate between the recommended pesticides. See Sanitation, page 9.

Read and follow label directions when applying any pesticide.

Tomato Disease Control

For general descriptions of tomato diseases, see Agriculture Canada publication 1479, *Tomato Diseases* and also OMAF Publication 526, *Growing Greenhouse Vegetables* (see inside back cover).

Resistance Code. Packets of greenhouse tomato seed, and most seed catalogs, use the following symbols to indicate the disease to which the cultivar is resistant.

C_2 – leaf mold partial resistance
C_5 – leaf mold complete resistance
F_1 – fusarium wilt, race 1
F_2 – fusarium wilt, races 1 and 2
Fr – fusarium crown and root rot
N – nematode resistance
Tm – tomato mosaic virus
V – verticillium resistance

Bacterial Canker

1. Buy seed from a reputable source.
2. If not pre-treated by supplier, see Hot Water Seed Treatment, page 53.
3. Follow a rigid schedule of sanitation throughout the growing season (page 9).
4. Remove and immediately destroy all diseased plants as soon as they are noted.
5. Follow other good sanitary practices, and spray with fixed copper (1 day) at 7-day intervals, or with a tank mix of fixed copper (1 kg) and mancozeb (1 kg) (1 day).
6. Work among infected plants last, after work in non-diseased areas is completed.
7. Disinfect tools, wash hands and launder clothing frequently.

Bacterial Stem Rot

First symptom is a sudden wilting of a few tomato plants, often scattered throughout the greenhouse. Plants so attacked will have hollow stems that may be partially filled with decaying plant tissue which has a foul odor. Soft, vigorously growing plants are often the first attacked. Although not serious in Ontario greenhouses to date, the disease merits further study. Contact your Vegetable Crops Advisor, or the Pathology Section, Agriculture Canada Research Station, Harrow, Ontario N0R 1G0, if the disease occurs. The disease is often more prevalent when the potassium to nitrogen (K:N) ratio in the feed formular is about 1:1, as compared to 2:1 or higher.

Blossom-end Rot

A non-parasitic disease that is related to water stress and calcium deficiency. If rapidly growing plants are suddenly exposed to drought, insufficient water enters the plant and blossom-end rot frequently occurs. Practice uniform watering, keep calcium levels adequate and avoid high rates of nitrogen application when plants are small.

Blotchy Ripening

Provide adequate space per plant, i.e. 0.33-0.42 m^2 (3.5-4.5 $ft.^2$); control virus diseases (page 57) and maintain relatively high potash levels. Keep greenhouse temperature as low as possible in hot weather. Avoid varieties known to be susceptible to blotch.

Corky Root

Thorough soil pasteurization with steam or fumigation with methyl bromide (page 10) is the only fully effective control. There are no registered postplanting controls. Where the disease is persistent in the soil in spite of pasteurization or fumigation, crop production in artificial media should be considered.

Damping-Off

1. Seedlings
   1. Treat seed with a reliable fungicide before sowing (page 53).
   2. Plant seed in a pasteurized soil or disease-free media.
   3. Raise seedlings on benches, not on the floor, and provide bottom heat.
   4. Provide adequate moisture by misting frequently or watering lightly, but do not overwater. Preheat the irrigation water to 21°C.
   5. Maintain good air movement in the seedling area. Ventilate freely but do not chill. Keep humidity low.
   6. Dust or drench diseased areas with a suitable fungicide such as captan, ferbam, or No-damp.
2. Late Damping-Off (Collar Rot)
   Several species of fungi, either alone or in combination, may attack newly transplanated tomato seedlings at ground level. The fungi cause the browning and decay of the outer layers of stem tissue, resulting in either total collapse of the plant, or severe retardation of growth. To control, sterilize the plant beds thoroughly and practice strict sanitation. Transplant seedlings into a warm soil. After transplanting, spray the stems and surrounding soil with Botran 75% (1.25 kg), or Ferbam 76% WDG (1.5 kg). Repeat in 7-10 days. Avoid cold water shock by pre-heating the irrigation water to 21°C. If it persists, consult with a disease specialist regarding the fungi involved and other control measures.

Early Blight, Late Blight, Septoria Leaf Spot

A first appearance, spray to keep new growth covered with:

1. Mancozeb WP, e.g. Dithane M-45, or Manzate 200-2 kg (1 day).

Fusarium Crown and Root Rot

This disease can be reduced by steaming the soil immediately after taking out the spring crop, and either leaving the ground fallow as long as possible, or growing lettuce to be harvested or rotovated in. No further sterilization is necessary before planting the next crop.

Infection is spread very fast from soil with wilted plants, so it is very important to raise seedlings in hygienic conditions well away from affected crops and unsterilized soil. Keep the greenhouses and surrounding areas clear of soil piles, trash, etc., that may harbor the disease. Ensure that soil temperature is adequate for planting. Avoid coil water chilling.

In the fruiting crop, soil mounded over layered stems will encourage new root production from the stem above the diseased area.

Resistant pink-fruited cultivars are now available. Resistant red cultivars are now being tested.

Grafting a desired cultivar to a resistant rootstock provides good control. Consult with your Vegetable Crops Advisor (page 4).

Fusarim Wilt, Verticillium Wilt, Black Dot Root Rot *(Colletotrichum)*

Before planting, steam soil or apply a soil fumigant (page 10). Many tomato cultivars are either partially or totally resistant. Check the resistance code on your seed package (see Resistance Code, page 56). Black dot root rot often occurs with Corky Root Rot (page 56) as a weak secondary disease.

Amounts of material are per 1000 litres of water unless otherwise stated.

Gray Mold *(Botrytis)*
Often becomes serious in spring (March-May) and in the autumn (September-November). Reduce humidity, provide good air circulation, ventilate freely, and apply one of:

1. Botran 75% WP-1.25 kg (1 day). Spray stem of plant from ground level to a height of 45-60 cm. Repeat weekly or as necessary. Seedlings or newly set transplants may be injured by drenching.
2. Ferbam 76% WDG-1.5 kg (1 day).
3. Rovral 50% WP-1 kg (2 days). Alternate with other recommended fungicides.
4. Benlate 50 WP-1.1 kg plus 2.25 kg Manzate 200 (1 day). NOTE: Many strains of *Botrytis* are resistant to Benlate. Alternate with other recommended fungicides.
5. Exotherm Termil smoke generators (1 day). Do not apply at temperatures above 24°C.

Leaf Mold
Grow resistant cultivars where possible (see Resistance Code, page 56). If susceptible varieties are grown, apply heat and provide good air circulation and ventilate. Remove diseased lower leaves if infection is severe. When leaf mold first appears, spray with Benlate 1.1 kg plus 2.25 kg Manzate 200 (1 day). Repeat at 7-12 day intervals.

Magnesium Deficiency
This will cause older leaves to turn pale green or yellow between the veins. At first appearance of this symptom, apply magnesium sulfate (Epsom salts) 2 or 3 times to the soil at 1-1.5 kg/100 m^2 or to the leaves as a spray (5 kg in 1000 L water). In greenhouses where the problem has occurred on previous crops, magnesium sprays should be applied even before the symptoms occur. A high potassium level in the soil may induce magnesium deficiency.

Tomato Mosaic Virus, Streak Virus, Shoestring
1. Grow cultivars resistant to, or tolerant to, ToMV (tomato mosaic virus). See Resistance Code, page 56.
2. Rogue out affected seedlings and plants if disease appears early. After handling diseased plants, field tomatoes, potatoes, bedding plants, field tomatoes, potatoes, bedding plants, and after smoking or handling tobacco in any form, wash hands with soap and water because the virus may be carried to greenhouse plants from such sources. Disinfect tools and boots. Launder clothing, and dry in the sun. ToMV can persist for long periods in contaminated coveralls, etc.
3. Infection with both ToMV and Potato Virus X (from potatoes) causes streak virus which severely damages tomato plants. Never handle potato tubers, vines, etc, and then proceed to work in your tomato crop.
4. Shoestring is caused by cucumber mosaic virus which is easily transmitted to tomato from cucumbers, melons or several species of weeds. Infection is most severe if it occurs when the tomato plants are very young (i.e. seedling and early transplant stage). Do not grow cucumbers close to the tomato crop, or work with tomatoes after handling cucumber crop that has mosaic.
5. Control aphids.
6. Seed treatment with trisodium phosphate (page 53) will help destroy ToMV on the seed coat, and is also a good disinfectant for tools, etc.

Tomato Insect Control

Aphids
Aphids mostly start on lower leaves and if noticed soon enough, can be eliminated by removing or destroying the infested leaves. If the aphids are more abundant or widespread, apply one of the following controls according to label directions:

1. Dibrom 10 mL/100 m^3 on heating pipes (1 day).
2. Parathion smokes (1 day).
3. Nicotine smokes (7 day).
4. Thiodan 50% WP 1 kg or Thiodan 4 EC 1.25-1.5 L or 3% dust 250 g/100 m^2 (1 day).
5. Aphid predators will provide adequate control under optimum conditions (see Integrated Pest Management, page 50).

NOTE: The insecticides listed above for aphid control are effective agaisnt several species of aphids that attack tomatoes, but only Nicotine smokes will kill the green peach aphid which may attack tomatoes. If in doubt as to species, consult with your Greenhouse Vegetable Pest Management Advisor, page 4).

Corn Earworm, Corn Borer, Cabbage Loopers
Often invade fall crops and bore into the fruit. At first appearance, spray with Dipel 1.25 kg or Thuricide HPC 2.8-5 L (1 day). Prevent entry of adults (moths) by screening doors and ventilators.

Cutworms
Apply a poison bran bait to the soil surface at 1.25 kg/100 m^2. The bait consists of Sevin 50% WP 1 kg stirred into 11 L water, mixed with 12 kg bran.

Greenhouse Whitefly
See Sanitation, page 9.

For biological control, see Integrated Pest Management, page 50. Also, see recommendations for Cucumber, page 53.

For chemical control, use one of the following:

1. Dibrom 10 mL/100 m^3 on heating pipes (1 day).
2. Thiodn 50% WP 1 kg or Thiodan 4 EC 1.25-1.5 L (1 day). NOTE: Many strains of whitefly are resistant to Thiodan; others may develop resistance after repeated applications.
3. Parathion smokes (1 day). Generally effective only against light infestations and in small greenhouse areas.
4. Permethrin, e.g., Ambush 500 EC 200 mL (1 day), or Pounce 384 EC 260 mL (1 day). NOTE: Resistance has developed in many areas.

The above materials mainly control adults. Repeat application at 5-day intervals to prevent egg laying by newly emerged adults. Alternate between insecticides to prevent the further build up of resistance.

Leafminer
Leafminer has been an occasional problem in greenhouse tomato crops. If seedlings for the spring crop are started while the previous fall crop is still in the greenhouses, leafminers will migrate from one to the other. Therefore, grow seedlings in isolated areas. Control all weeds and other vegetation which might provide alternate host material for leafminers.

Monitor leafminer populations by using sticky yellow boards to trap adults (see page 55). Control measures must begin when adults first appear. Spray with:

1. Ambush 50 EC (1 day), used as for greenhouse whitefly, will help control leafminers; or apply

Read and follow label directions when applying any pesticide.

2. Malathion 25% WP, 4 kg (3 days), or Malathion 500 EC, 1.75 L (3 days). Repeat at 4-day intervals.

NOTE: Several species of parasitic wasps that occur naturally in the environment are very helpful in controlling leafminers.

Root-Knot Nematode

The species usually attacking greenhouse tomatoes is the southern root knot nematode.

Use control as cucumber, page 55.

Thrips

Seldom troublesome on tomatoes. If required, use one of the chemicals listed for greenhouse whitefly (page 55). NOTE: The western flower thrips is a vector for tomato spotted wilt virus. This disease to date, has not been extensively troublesome on greenhouse tomatoes. However, if thrips attack your tomato crop, please consult with your Pest Management Advisor (page 4)

Two-Spotted Spider Mite

Rarely a pest on tomatoes in Ontario, but a few recently introduced cultivars appear to be more susceptible to damage. Because cucumbers are very susceptible to spider mite damage, it is not advisable to grow tomatoes close to cucumber plants. If required, use same control as for cucumber, page 55.

Pepper Disease Control

The principal disease of greenhouse peppers are tobacco mosaic virus, cucumber mosaic virus, gray mold (*Botrytis*), and the physiological disorder, Blossom-end rot.

No pesticides are registered on greenhouse peppers and none can be legally used.

For general information on hygiene and handling crops to avoid diseases, see the remarks on tomato diseases, page 56, and sanitation, page 9.

Pepper Insect Control

Thrips

The western flower thrip is the predominant species, while onion thrips and eastern flower thrips may also be present. These thrips can occur on the crop any time after transplanting, and are found on the leaves, blossoms and fruit. The thrips can be monitored using yellow or blue sticky traps, with blue being the preferred color. Once thrips are detected in the greenhouse, biological control measures should be implemented.

Biological Control. The predatory mite *Amblyseius cucumeris* is commercially available for thrips control on peppers. Usually, only 2-3 introductions of the predators are needed to achieve control of thrips. The predator can survive and reproduce in the absence of thrips becuase it will feed on pollen. However, the predator does not cause any damage to the pepper plant or fruit.

For information on obtaining predators, introduction rates, and monitoring of thrips and their predators, consult with your Greenhouse Vegetable Pest Management Advisor, page 4.

Aphids

Aphids, especially the green peach aphid, can be a problem on peppers any time throughout the season. Aphids secrete honeydew like whiteflies, and thus the same problems with black sooty mold on the leaves and fruit occur. When aphid numbers exceed 5/leaf, honeydew accumulations begin to be economically important. Aphids can be effectively controlled using cultural, biological, or chemical control strategies.

Cultural Control. See Cucumber Pests, page 54.

Biological Control. The parasitic wasp, *Aphidius matricariae*, and the predatory midge *Aphidoletes aphidimyza* are both available commercially for biocontrol of aphids. For best results, use early releases of *A. matricariae* combined with larger introductions of *A. aphidimyza* in March.

For information on obtaining the biocontrol agents, introduction rates, and monitoring for control of aphids, consult your Greenhouse Vegetable Pest Management Advisor, page 4.

Chemical Control. Aphids can be controlled using insecticidal soap, but repeated soap applications can damage the plants. Both biocontrol agents are susceptible to insecticidal soap.

Cabbage Loppers, Corn Borers, and Other Caterpillars

Occasionally troublesome in peppers. Spray with Dipel, 1.25 kg (1 day), or Thuricide HDC, 2.8-3.5 L (1 day).

Two-Spotted Spider Mites

See Greenhouse Cucumber section, Biological Control, page 55.

Lettuce Disease Control

Damping-Off and Bottom Rot

Certain fungi, such as Botrytis, Rhizoctonia, and Sclerotinia can cause damping-off of lettuce seedlings, or root decay and rotting at ground level (bottom rot) if the attack occurs later in the growing season.

Thoroughly sterilize the soil with steam (page 10) in severely infested greenhouses. Provide adequate moisture, but do not overwater. Maintain good air movement in the greenhouse, ventilate freely and keep humidity at moderate levels.

Spray seedlings before transplanting with ferbam 76% WDG, 1.5 kg (1 day). Repeat once or twice after transplanting, as needed, at 7-10 day intervals.

Downy Mildew

Occasionally a problem in late summer and fall crops, especially in plastic greenhouses where high humidity occurs. Provide adequate temperature and ventilation to avoid prolonged periods of leaf wetness. If the disease appears, spray thoroughly with Zineb 80% WP, 1.75-2.25 kg (10 days).

Resistant cultivars are available, but it is necessary to know what the local races of downy mildew are. Consult with your Greenhouse Vegetable Pest Management Advisor, page 4.

Lettuce Insect Control

Aphids

Nicotine smokes (7 days).

Cabbageworms, Cabbage Loppers and Other Caterpillars

Often Troublesome in early fall. Spray with Dipel 1.25 kg, or Thuricide HPC 2.8-3.5 L (1 day).

Amounts of material are per 1000 litres of water unless otherwise stated.

SUMMARY OF REGISTERED PESTICIDES (TRADE NAMES) FOR GREENHOUSE VEGETABLES

	CHEMICAL	RATE/1000 L WATER[a]	HARVEST INTERVAL/ REMARKS[b]
	CUCUMBER DISEASES		
Basal and Stem Rot	Ferbam 76% WDG	2 kg	1d. Occasionally causes injury to English seedless cucumbers.
Damping-Off	Ferbam 76% WDG	1.5-2 kg	
Downy Mildew	Benlate 50 WP Plus Manzate 200	550-850 g 2.25 kg	5d.
	Maneb 80% WP	2 kg	3d.
Gray mold (Botrytis)	Ferbam 76% WDG	1.5-2 kg	1d.
	Rovral 50 WP	1 kg	2d.
Gummy Stem Blight	Benlate 50 WP Plus Manzate 200	550-850 g 2.25 kg	5d.
Leaf Spots (Alternaria, Anthracnose)	Maneb 80% WP	750 g	5d.
	Benlate 50 WP Plus Manzate 200	550-850 g 2.25 kg	5d.
Powdery Mildew	Micro-Niasul 92% wettable sulfur	.75-1.5 kg	1d.
	Kumulus S-80% dispersable granular sulfur	120 g/100 L	
	CUCUMBER INSECT/MITE PESTS		
Aphids	Dibrom	10 mL/100[3] on heating pipes	1d. May injure seedless cucumber blossoms.
	Thiodan 50% WP, or Thiodan 4 EC	1 kg 1.75-1.5 L	1d.
	Parathion smokes	Follow label directions	1d.
	Nicotine smokes	Follow label directions	7d.
Thrips	As for aphids, or Ambush 500 EC, or Pounce 384 EC, or Lannate	200 mL 260 mL 22 mL/100 L water	1d. 1d. 3d.

[a] *Rate as given unless otherwise stated.*
[b] *Interval that must elapse between application and harvest given in days.*

	CHEMICAL	RATE/1000 L WATER[a]	HARVEST INTERVAL/ REMARKS[b]
Two-Spotted Mite	Vendex 50 W	500 g - 1 kg	5d.
	Kelthane AP 35%	750 g	3d.
	Dibrom	As for aphids	ld. May injure seedless cucumber blossoms.
Whitefly	As for thrips		
	TOMATO DISEASES		
Early Blight	Mancozeb WP (Manzate 200) (Dithane M45)	2 kg	ld.
Gray Mold (Botrytis)	Botran 75% WP	1.25 kg	ld.
	Ferbam 76% WDG	1.5-2 kg	ld.
	Rovral 50% WP	1 kg	2d.
	Benlate 50 WP plus Manzate 200	1.1 kg 2.25 kg	ld.
	Exotherm Termil smoke generators	Follow label directions	ld.
Late Blight	As for early blight		
Late Damping-Off	Botran 75%	1.25 kg	
	Ferbam 76% WDG	1.5 kg	
Leaf Mold	Benlate 50 WP plus Manzate 200	1.1 kg 2.25 kg	ld.
	TOMATO INSECT/MITE PESTS		
Aphids	As for cucumbers		
Cabbage Loopers	Dipel, or Thuricide HPC	1.25 kg 2.8-5 L	ld.
Corn Borer	As for cabbage loopers		
Corn Earworm	As for cabbage loopers		

[a] *Rate as given unless otherwise stated.*
[b] *Interval that must elapse between application and harvest given in days.*

DISEASES	CHEMICAL	RATE/1000 L WATER[a]	HARVEST INTERVAL/ REMARKS[b]
Cutworms	Sevin 50% WP	Apply 1.25 kg poison bait/100 m^2	To make bait, stir 1 kg Sevin 50% WP into 11 L water and mix with 12 kg bran.
Leafminer	Ambush 500 EC	200 mL	1d.
	Malathion 25% WP	4 kg	3d.
	Malathion 500 EC	1.75 L	3d.
Thrips	Dibrom	10 mL/100 m^3 on heating pipes.	1d.
	Thiodan 50% WP, or Thiodan 4 EC	1 kg 1.25-1.5 L	1d.
	Parathion smokes		1d.
	Ambush 500 EC, or Pounce 384 EC	200 mL 260 mL	1d. 1d.
Two-Spotted Mite	As for cucumbers		
Whitefly	As for cucumbers		
	PEPPER INSECTS		
Cabbage Loopers	Dipel Thuricide	1.25 kg 2.8-3.5 L	1d. 1d.
	LETTUCE DISEASES		
Damping-off and Bottom Rot	Ferbam 76% WDG	1.5 kg	1d.
	LETTUCE INSECTS		
Aphids	Nicotine smokes	Follow label directions	7d.
Cabbageworms	Dipel Thuricide HPC	1.25 kg 2.8-3.5 L	1d. 1d.

[a] *Rate as given unless otherwise stated.*
[b] *Interval that must elapse between application and harvest given in days.*

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm)	= 1 centimetre (cm)
100 centimetres (cm)	= 1 metre (m)
1000 metres	= 1 kilometre (km)

Square Measures (area)

100 m × 100 m	= 10,000 m^2 = 1 hectare (ha)
100 ha	= 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3)	= 1 cubic centimetre (cm^3)
1,000,000 cm^3	= 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL)	= 1 litre (L)
100 L	= 1 hectolitre (hL)

Weight — Volume Equivalents (for water)

(1.00 kg) 1000 grams	= 1 litre (1.00 L)
(0.05 kg) 500 g	= 500 mL (0.05 L)
(0.10 kg) 100 g	= 100 mL (0.10 L)
(0.01 kg) 10 g	= 10 mL (0.01 L)
(0.001 kg) 1 g	= 1 mL (0.001 L)

Weight Measures

1000 milligrams (mg)	= 1 gram (g)
1000 g	= 1 kilogram (kg)
1000 kg	= 1 tonne (t)
1 mg/kg	= 1 part per million (ppm)

Dry — Liquid Equivalents

1 cm^3	= mL
1 m^3	= 1000 L

APPLICATION RATE CONVERSIONS

(approximate)

Metric to Imperial (Approximate)

litres per hectare x 0.09	= gallons per acre
litres per hectare x 0.36	= quarts per acre
litres per hectare x 0.71	= pints per acre
millilitres per hectare x 0.015	= fluid ounces per acre
grams per hectare x 0.015	= ounces per acre
kilograms per hectare x 0.89	= pounds per acre
tonnes per hectare x 0.45	= tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23	= litres per hectare (L/ha)
quarts per acre x 2.8	= litres per hectare (L/ha)
pints per acre x 1.4	= litres per hectare (L/ha)
fluid ounces per acre x 70	= millilitres per hectare (mL/ha)
tons per acre x 2.24	= tonnes per hectare (t/ha)
pounds per acre x 1.12	= kilograms per hectare (kg/ha)
ounces per acre x 70	= grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLES — METRIC TO IMPERIAL

Length

1 millimetre (mm)	= 0.04 inch
1 centimetre (cm)	= 0.40 inch
1 metre (m)	= 39.40 inches
1 metre (m)	= 3.28 feet
1 metre (m)	= 1.09 yards
1 kilometre	= 0.62 mile

Volume (liquid)

1 millilitre (mL)	= 0.035 fluid ounce
1 litre (L)	= 1.76 pints
1 litre (L)	= 0.88 quart
1 litre (L)	= 0.22 gallon (Imperial)
1 litre (L)	= 0.26 gallon (U.S.)

Weight

1 gram (g)	= 0.035 ounce
1 kilogram (kg)	= 2.21 pounds
1 tonne (t)	= 1.10 short tons
1 tonne (t)	= 2205 pounds

Pressure

1 kilopascal (kPa)	= 0.15 pounds/square inch

Area

1 square centimetre (cm^2)	= 0.16 square inch
1 square metre (m^2)	= 10.77 square feet
1 square metre (m^2)	= 1.20 square yards
1 square kilometre (km^2)	= 0.39 square mile
1 hectare (ha)	= 107,636 square feet
1 hectare (ha)	= 2.5 acres

Volume (dry)

1 cubic centimetre (cm^3)	= 0.061 cubic inch
1 cubic metre (m^3)	= 1.31 cubic yards
1 cubic metre (m^3)	= 35.31 cubic feet
1000 cubic metres (m^3)	= 0.81 acre-foot
1 hectolitre (hL)	= 2.8 bushels

Speed

1 metre per second	= 3.28 feet per second
1 metre per second	= 2.24 miles per hour
1 kilometre per hour	= 0.62 mile per hour

Temperature

°F = (°C x 9/5) + 32
°C = (°F - 32) x 5/9

CONVERSION TABLES — IMPERIAL TO METRIC

Length

inch	= 2.54 cm
foot	= 0.30 m
yard	= 0.91 m
mile	= 1.61 km

Area

square foot	= 0.09 m^2
square yard	= 0.84 m^2
acre	= 0.40 ha

Weight

ounce	= 28.35 g
pound	= 453.6 g
ton	= 0.91 tonne

Volume (Dry)

cubic yard	= 0.76 m^3
bushel	= 36.37 L

Volume (liquid)

fluid ounce (Imp.)	= 28.41 mL
pint (Imp.)	= 0.57 L
gallon (Imp.)	= 4.55 L
gallon (U.S.)	= 3.79 L

Pressure

pound per square inch	= 6.90 kPa

PUBLICATIONS FOR FURTHER INFORMATION

1. Ministry of Agriculture and Food

Numbered Publications

40 *Greenhouses*
65 *Energy Conservation in Ontario Greenhouses*
284 *Ontario Farm Record Book (Horticulture and Cash Crops)*
485 *Growing Vegetable Transplants*
526 *Growing Greenhouse Vegetables*

Factsheets

250/23 *Vegetable Seed Treatments*
290/15 *Water Quality for Greenhouse Crops*
290/27 *Using Carbon Dioxide in Greenhouses*
290/92 *Air Pollution Problems in Greenhouses*
290/518 *Soilless Culture of Greenhouse Vegetables*
290/532 *Leaf Analysis for Greenhouse Vegetable Crops*
290/613 *Using Parasites for Whitefly Control of Greenhouse Vegetables*
291/635 *Bacterial Canker of Tomato*
292/21 *Growing European Seedless Cucumbers*
292/685 *Gummy Stem Blight of Seedless Cucumbers*
295/15 *Seed Propagated Free-Flowering Geraniums*
296/510 *Composts and Soilless Mixes for Transplants*
296/601 *Metrics for Agriculture – Greenhouse and Mushroom Pesticides*
607 *Farm Storage of Pesticides*

Available from the Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto, Ontario M7A 1A5, or from County Offices of the Ministry, or from the Crops Advisor serving your area. For a complete publication list, obtain the most recent listing from the Communications Branch.

2. Ministry of the Environment

Personal Protective Equipment for Pesticide Users
Pesticide Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs

Available from the Pesticides Section, Suite 100, Ministry of the Environment, 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5.

3. Agriculture Canada

Numbered Publications

#1479 *Tomato Diseases*
#1684 *Cucumber Diseases*

Available from Information Services, Agriculture Canada, Harrow, Ontario N0R 1G0.

Unnumbered Publications

Standby Electric Power (Hydro)

RV-1-90-20M
@QUEEN'S PRINTER FOR ONTARIO, 1990
ISSN 1180-0054